SOIL SURVEY

Coalinga Area California

Series 1944, No. 1

Issued December 1952

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
and
Forest Service
In cooperation with the
UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

FARMERS who have lived in one locality for a long time come to know about the soil differences on their own farms and on those of their immediate neighbors. What they do not know, unless a soil survey has been made, is how nearly their soils are like those at experiment stations or in other localities from which higher yields are reported. They do not know whether these higher yields are from soils like their own or so different that they could not hope to get equally high returns, even if they adopted the practices followed in these other places. The similarities and differences among soils are known only after a map of the soils has been made. Knowing what kind of soil one has and comparing it with soils on which new developments have proved successful will remove some of the risk in trying new methods and varieties.

SOILS OF A PARTICULAR FARM

To find what soils are on any farm or other land, locate the tract on the soil map, which is in the envelope inside the back cover. This is easily done by finding the township, section, and quarter section the farm is known to be in and locating its boundaries by such landmarks as roads, streams, villages, and other features.

Each kind of soil is marked with a symbol on the map; for example, all soils marked Kb are the same. To find the name of the soil so marked, look at the legend printed near the margin of the map and find Kb. The color where the symbol appears in the legend will be the same as where it appears on the map. The Kb means Kettleman clay loam, rolling. The section of this report on Soil Descriptions tells what Kettleman clay loam, rolling, is like, for what it is mainly used, and some of the uses to which it is suited.

How productive is Kettleman clay loam, rolling? See tables 5 and 6 and note its relative suitability for the different crops. These tables also give the relative crop suitabilities for all the other soils mapped, so that the different soils may be compared.

SOILS OF THE AREA AS A WHOLE

If a general idea of the soils of the area is wanted, read the introductory part of the section on Soils. This tells where the principal kinds are found, what they are like, and how they are related to one another. Then study the soil map and notice how the different kinds of soils tend to be be arranged in different localities. These patterns are likely to be associated with well-recognized differences in type of farming and land use.

A newcomer who considers purchasing a farm in the area will want to know about the climate as well as the soils; the types of farms; the principal farm products and how they are marketed; kinds of farm equipment and machinery; availability of schools, churches, highways, railroads, telephone and electric services, and water supplies; industries; and towns and population characteristics. This information will be found in the sections on General Nature of the Area and on Agriculture.

Students and others interested in how the soils of the area were formed and how they are related to the great soil groups of the world should read the section on Morphology and Genesis of Soils.

This publication on the soil survey of the Coalinga area, Calif., is a cooperative contribution from the—

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SOIL SURVEY OF THE COALINGA AREA, CALIFORNIA

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United States Department of Agriculture in cooperation with the University of California Agricultural Experiment Station

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IN the Coalinga area most crops are irrigated by wells or, along Fresno Slough, by diversion canals. The major crops are barley, flax, and cotton. Truck crops and melons are well adapted, and improvement and extension of irrigation facilities should make their production more important. A few dairy and some beef cattle are raised, but sheep are the principal livestock. Oil production is the

main industry, and all other businesses are connected with it. To provide a basis for the best agricultural use of the land a cooperative soil survey was made by the United States Department of Agriculture and the University of California Agricultural Experiment Station. The survey was completed in 1944, and unless otherwise specifically mentioned, all statements pertain to conditions at the time of survey.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

The Coalinga area covers most of the southwestern part of Fresno County and lies on the west side of the middle part of the San Joaquin Valley. The town of Coalinga is 185 miles northwest of Los Angeles, 160 miles southeast of San Francisco, and 180 miles southeast of Sacramento (fig. 1).

The surveyed area comprises 572 square miles, or 366,080 acres. It is roughly rectangular, with the longer axis paralleling the northwesterly course of Fresno Slough. The northern boundary, a line between Townships 15 and 16 south, joins the survey of the Mendota area.[1] The southeastern boundary and part of the eastern boundary join the soil survey of Kings County (*6*)[2] at the Fresno-Kings County line. Fresno Slough forms the northeastern boundary. An arbitrary western boundary was chosen at the 1,000-foot contour along the foothills of the Diablo Range, part of the Coast Range. Practically all the land in the Coalinga area survey was covered by the early reconnaissance soil survey of the Middle San Joaquin Valley (*1*), and a small part along the eastern edge was included in the early soil survey of eastern Fresno County (*9*).[3]

The Coast Range, which flanks the west side of the Great Interior Valley, particularly the Coalinga area, is a series of comparatively low parallel ridges that rarely reach an elevation of 3,000 feet. The ridges are composed almost entirely of sandstone and shale that may or may not be calcareous. They form a natural barrier against coastal winds and fogs, thus creating a "rain shadow" on the eastern side of the mountains and on the western side of the valley.

Because of the arid character of the eastern part of the mountains near the Coalinga area, only a few intermittent creeks, such as Arroyo Hondo, Cantua, Salt, Domengine, Los Gatos, Waltham, Jacalitos, and Zapato, drain the slopes bordering the surveyed area on the eastern side and enter the San Joaquin Valley. These small intermittent creeks have maintained a relatively low but fluctuating discharge for

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[1] HARRADINE, F. F., GARDNER, R. A., ROOKE, L. G., and KNECHT, E. A. SOIL SURVEY OF THE MENDOTA AREA, CALIFORNIA. U. S. Dept. Agr., Bur. Plant Industry, Soils, and Agr. Engin. [In press.]

[2] Italic numbers in parentheses refer to Literature Cited, p. 91.

[3] The purpose of these earlier surveys was to obtain general information in a short time over a large area. In the present survey, a smaller area is mapped in greater detail and the soils are classified through more intensive field observation and technical study. Development in soil science and soil classification since the earlier surveys has resulted in the recognition of new soil series and the dividing of former more inclusive categories into two or more soil series. The most important of these differences in soil classification are noted in the report.

FIGURE 1.—Location of the Coalinga area in California.

many years and have built up a series of large gently sloping alluvial fans. Their waters seldom reach the Fresno Slough-San Joaquin River drainage system even during flood periods. Small levees and shallow ditches have been constructed near the mouth of some of the larger creeks to control and to utilize more effectively the annual runoff.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

The Coalinga area lies within the Central Valley, or Great Interior Valley, of California, which is an elongated trough or basin paralleling the eastern and western boundaries of the State in a northwest-southeast trend. The valley stretches from above Redding

in the north to below Bakersfield, a distance of about 500 miles. Its average width is about 40 miles, and mountain ranges enclose it except for one break on the west side where drainage waters have an outlet to San Francisco Bay and the Pacific Ocean.

Actually, the Great Interior Valley consists of two valleys—the Sacramento Valley, the northern and smaller part, which is drained by the Sacramento River, and the San Joaquin Valley, the southern section, drained in part by the San Joaquin River. The Kings River enters the southern part of the San Joaquin Valley and originally emptied into Tulare Lake. Much of the river water is now artificially diverted into Fresno Slough, which lies along the northeastern boundary of the Coalinga area and flows northward into the San Joaquin River. The slough is the only drainage outlet for the upper San Joaquin Valley; none of the other rivers or streams of the upper part of the valley have channels that connect with the main drainage system. During exceptional floods, however, water has flowed the full length of the valley.

The low axial trough of the Central Valley slopes slightly northward. Beginning with an elevation of 217 feet above sea level at the intersection of Fresno Slough with the Kings County line, there is an average drop of less than 2 feet per mile northwestward along Fresno Slough for a distance of about 34 miles to the junction of the slough with the San Joaquin River. The elevation at this junction is 160 feet, and northward the gradient increases very slightly. The level or nearly level basin included in the Coalinga area varies irregularly from 1 to 6 miles in width and joins on the west the outer edge of coalescent alluvial fans. The fans have a uniform very gently sloping relief, the average gradient being less than 1 percent, to an elevation of about 400 feet. The percentage of slope increases to about the 500-foot contour, which roughly marks the base of the upland areas with steeper slopes.

Pleasant Valley, in the southwestern part of the area near Coalinga, is roughly rectangular in shape—about 6 miles wide and 12 miles long, with the longer part in a northwest-southeast position. It is enclosed on three sides by the foothills of the Coast Range and by protruding ridges. Polvadero Gap, in the southeastern part of the valley between the Guijarral and Kettleman Hills, is the widest natural outlet, but most of the drainage is through Arroyo Pasajero to the north. The very gently sloping valley floor ranges in elevation from about 550 feet near Polvadero Gap to approximately 850 feet northeast of Coalinga at the base of the foothills. Coalinga has an elevation of 663 feet and is a few miles southwest of the geographical center of the valley.

Los Gatos, Waltham, and Jacalitos Creeks drain the upland area west of Pleasant Valley and then join east of Coalinga to form Arroyo Pasajero, a deeply cut drainage outlet between Anticline Ridge and the Guijarral Hills. Zapato and Canoas Creeks join and pass through Polvadero Gap, and the water is normally dispersed on the valley floor about 5 miles southwest of Huron. Floodwaters from all these creeks are soon dissipated on the soils of the alluvial fans near Huron. Much of the water from the creeks is used for irrigation within Pleasant Valley. More than 80 percent of the soils of the Coalinga area have good or excellent surface and subsoil drainage; the rest are basin and semibasin soils subject to a periodic high water table.

CLIMATE

The arid Coalinga area is characterized by two contrasting seasons in precipitation, temperature, and humidity. The relation of precipitation to temperature at Coalinga is graphically presented in figure 2.

During the dry summer season—from April to October—rainfall is generally lacking for long periods. Average temperatures are high during the cloudless midsummer days, and maximum temperatures range between 100° and 110° F. for a week or two at a time. The hot dry summers are bearable because of the accompanying low relative humidity and the northerly breezes that prevail in the evening. The

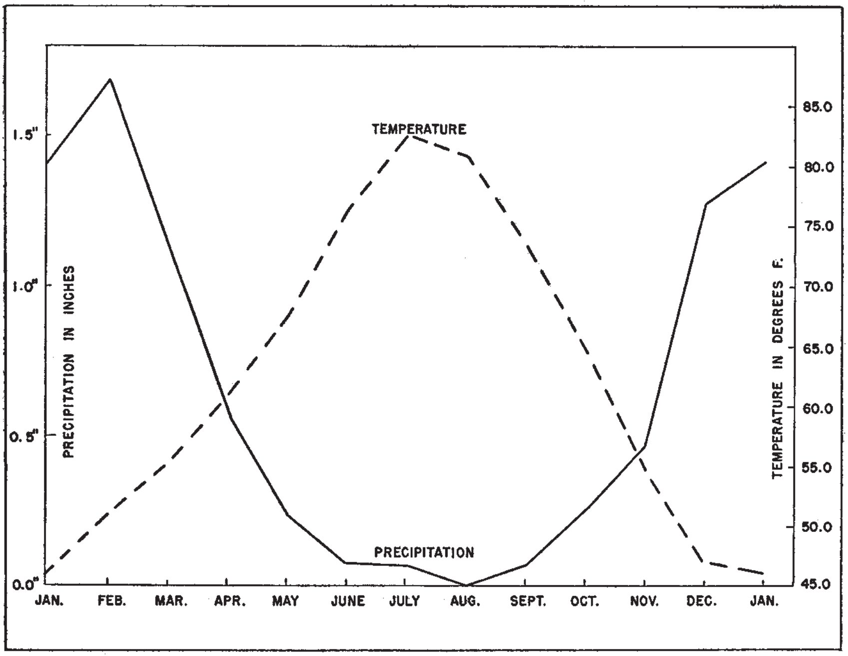

FIGURE 2.—Relation of precipitation to temperature at Coalinga, Calif.

range of temperature between day and night is great, and although temperature may be high for a few hours during the afternoon, a rapid fall in temperature begins at sunset, and the nights are pleasantly cool.

Practically all of the annual rainfall occurs in the winter, or wet season, from November to April. In December, January, and February occur the greatest precipitation, high relative humidity, and low temperatures that frequently reach the freezing point during the night. Winter is not severe and, aside from the average 40 or fewer rainy days and a few foggy or cold days, is mild and pleasant. The rain usually occurs at night, especially in spring or autumn, so there is little interference with work or recreation. Thunderstorms are rare. Fogs are confined to a relatively short season and seldom persist throughout a whole day.

Frost and freezing conditions are relatively uniform throughout the central San Joaquin Valley. During the frost season the temperature commonly rises more than 20 degrees above freezing before noon. At Coalinga the average dates of killing frost are March 16 and November 22, making the average length of the growing season 251 days. The latest and earliest recorded dates of killing frost are May 8 and October 31, respectively.

Average wind movement during summer is about 8 miles an hour, and during winter, less than 5 miles. Velocities are moderate, and severe windstorms are rare. North is the prevailing wind direction for nearly all months, and in the summer the wind blows north about 75 percent of the time. The daily fluctuations in air movement during summer months are fortunate; after sunset, the breeze freshens and is generally strongest from 9 p. m. until midnight, when it reaches an average velocity of about 12 miles an hour.

The normal monthly, seasonal, and annual temperature and precipitation at Coalinga are given in table 1.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Coalinga, Fresno County, Calif.*

[Elevation, 663 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year
	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*
December	47.0	80	13	1.26	0.67	2.92
January	46.1	81	11	1.39	1.53	1.70
February	50.9	90	18	1.69	1.16	4.00
Winter	48.0	90	11	4.34	3.36	8.62
March	54.9	89	22	1.13	.08	3.47
April	60.6	100	28	.57	.05	1.18
May	67.5	106	29	.25	.57	0
Spring	61.0	106	22	1.95	.70	4.65
June	75.7	118	35	.09	(1)	(1)
July	82.3	120	47	.06	0	0
August	80.2	116	33	.01	0	0
Summer	79.4	120	33	.16	0	0
September	73.6	111	32	.06	.05	0
October	64.8	108	24	.26	0	.64
November	54.5	90	17	.46	.40	.58
Fall	64.3	111	17	.78	.45	1.22
Year	63.2	120	11	7.23	[2] 4.51	[3] 14.49

[1] Trace. [2] In 1932. [3] In 1941.

VEGETATION

The only trees growing in this predominantly treeless area (pl. 1, *A*) are the few along some of the creeks and along Fresno Slough and the shade of fruit trees that have been planted around farmsteads and along roadways. Before extensive cultivation, the basin area was covered with an abundant growth of tules and water-tolerant grasses. The grasses were cut and stacked for range-cattle feed during the dry season. Only a few scattered patches of natural grasses remain in uncultivated areas. Where alkali [4] is present, the cover is largely saltgrass (*Distichlis stricta*) and alkali bunchgrass or alkali sacaton (*Sporobolus airoides*).

On the outer edge of the fans, where the salt content is variable but frequently high, there is a dominance of big saltbush or quailbrush (*Atriplex lentiformis*) and other varieties of alkali-tolerant plants, such as pickleweed, iodine bush (*Allenrolfea occidentalis*), and sea heath (*Frankenia grandifolia*). The higher and well-drained parts of the fans during years of favorable rainfall have a fair cover of red or foxtail bromegrass (*Bromus rubens*) mixed with several other species of annual grasses and some alfileria (*Erodium cicutarium*). A scant covering of brush resembling shadscale (*Atriplex confertifolia*) is found near the base of the foothills. For a few weeks each spring there is a brilliant cover of wild flowers, dominated by the California-poppy (*Eschscholtzia californica*) and lupine, on the foothills surrounding Pleasant Valley. The range grasses are now being heavily grazed by sheep, and therefore many foothill areas are practically barren most of the year. Recent bad burns have further reduced the natural grass cover.

SETTLEMENT AND POPULATION

The limited accounts of early settlement in the arid southwestern part of the San Joaquin Valley indicate that many Indian tribes roamed the plains of the valley before the arrival of white settlers, but that few of them ever went west of Tulare Lake. The Tache tribe hunted in Pleasant Valley, and the Tulamni tribe lived on the west shores of Buena Vista Lake in Kern County (*7*). For the most part, the Indians concentrated in regions of adequate water supply on the east side of the valley trough, and only a few tribes ever ventured west of the San Joaquin River except on occasional hunting trips. Fish and game were plentiful, and the Indians lived on the bounty of the land without farming.

From 1840 to 1860 the Indian population decreased as white settlers, mainly sheepherders and cattlemen, arrived. Early permanent settlement of southwestern Fresno County was slow, and most of the settlers who did remain on their small homesteads abandoned them by 1870 because they did not have an adequate income. Land companies later bought these homesteads and successfully operated large cattle ranches (*11*, *13*).

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[4] The term "alkali" is used in this report in its local popular agricultural sense and includes both salts of neutral chemical reaction, such as the chloride and the sulfate of sodium, as well as the true alkali carbonates of more toxic character. For a discussion of alkali soils in the area see the section on Alkali.

The present site of Coalinga was homesteaded by M. L. Curtis in 1882, but the town was not incorporated until 1906. It became a trading center for sheep and cattle and a center for coal mining, from which the name Coalinga is derived. Coalinga advanced with development of the oil resources, and from a village of 20 houses in 1900, it grew to an estimated population of 10,000 at the height of the oil boom in 1910. It is the second largest community in Fresno County, the only town in the Coalinga area, and the largest city in California supported mostly by the oil industry. In 1950 it had a population of 5,520. The population is fairly stable, and it does not include the many hundreds of workers who live in villages in the surrounding oil fields. Fresno County had a total population of 276,515 in 1950, but only a small percentage lived within the area covered by this survey.

INDUSTRIES, TRANSPORTATION, AND MARKETS

Oil is the principal industry of this area; all other business activities are directly or indirectly connected with and dependent upon oil resources. The Coalinga and nearby oil fields are heavy producers, and Coalinga has prospered with the oil industry. Most of the oil is pumped through pipelines to the San Francisco Bay region for processing.

Passenger travel in the Coalinga area is by two bus lines. The bulk of the freight is carried by trucks, but part is hauled by a branch railroad that connects Coalinga with the main railroads on the east side of the valley. Drinking water is brought in by tank car from Armona in Kings County.

Fresno is the main shopping and warehouse center for western Fresno County and the principal outlet for agricultural products and cattle. Los Angeles and San Francisco still receive a part of the business and produce of this region, but Fresno is rapidly becoming the exclusive marketing and buying center. Cotton, flax, barley, and some truck crops, such as melons and carrots, are the chief crops sent to market. Beef cattle and sheep are the principal animal products. Practically all of the dairy output is consumed locally.

PUBLIC FACILITIES

Coalinga has an excellent primary and secondary school system. The buildings are new and modern, and the equipment, shops, and recreational facilities are far above average. A bus system supplies transportation for rural pupils. A public library and both Catholic and Protestant churches are also located within the town. Telephone installations per capita are exceptionally high.

AGRICULTURE

Between 1880 and the turn of the century several land companies made a serious attempt at dry farming grain in the area. This venture was uncertain under existing arid conditions, and losses usually offset gains. Not until the oil boom around 1910 was much attention given to crops; before that time Coalinga was primarily a sheep and cattle trading post.

The first successful farms were established along Fresno Slough, where water for irrigation was easily obtainable. In the early eighties the Sunset Irrigation Company attempted reclamation of about 400,000 acres on the arid west side by taking water from the San Joaquin River, but irrigation failed because the large ditch and the diversion dams were subject to frequent and costly wash-outs. By 1915, grain farming near Fresno Slough was important. Wheat, originally the main crop, was soon replaced by barley, which was better adapted to the dry climate. Many sections were irrigated by canals from Fresno Slough and by runoff water from the foothills. As irrigation facilities were developed, more attention was given to diversified farming and dairying, especially in Pleasant Valley. A large farming company once attempted growing fruit in the vicinity of Westhaven, but none of marketable quality has been produced in southwestern Fresno County.

CROPS

Barley, flax, and cotton are the three major crops in the area. Except for a relatively small acreage of dry-farmed barley, practically all the crops are irrigated by water from wells with fairly high

TABLE 2.—*Crop acreages and number*[1] *of bearing fruit trees and grapevines in Fresno County, Calif., and proportion*[2] *in the Coalinga area*

Crop	Fresno County				Coalinga area
	1919	1929	1939	1944	1944
	Acres	*Acres*	*Acres*	*Acres*	*Percentage of crops in county*
Barley	36, 252	35, 138	60, 938	93, 948	46
Flax	(3)	(3)	30, 891	43, 628	33
Cotton	5, 551	51, 457	70, 224	68, 496	10
Grain sorghums	(3)	1, 558	3, 167	4, 382	48
Oats for grain	1, 282	1, 238	3, 293	4, 239	18
Wheat for grain	27, 476	25, 132	21, 780	15, 951	10
Alfalfa	64, 056	51, 897	46, 079	78, 804	10
Small-grain hay	23, 619	23, 973	17, 007	5, 234	[4] 12
Other tame hay	1, 203	1, 348	1, 271	3, 241	(3)
Vegetables [5]	635	2, 396	5, 092	21, 493	(3)
	Number	*Number*	*Number*	*Number*	*Number*
Peaches trees	2, 515, 288	1, 099, 549	770, 365	1, 154, 160	(3)
Plums and prunes do	120, 963	318, 217	148, 954	268, 162	(3)
Oranges do	150, 577	205, 868	230, 415	231, 886	(3)
Grapevines	59, 868, 677	84, 501, 144	74, 788, 483	81, 396, 930	(3)

[1] 1944 figures are for trees of all ages.
[2] Proportion estimates are based on U. S. census figures for townships 6 and 15, the cropland area of these 2 townships being covered almost entirely by the Coalinga area. Fourteen percent of the 604,299 acres of cropland harvested in Fresno County in 1944 was in the Coalinga area.
[3] Not reported.
[4] Percentage based on 1939 figures.
[5] Includes sweetpotatoes and Irish potatoes.

average water lifts. A small area along Fresno Slough is irrigated by diversion canals. The dry-farmed barley receives supplemental moisture from controlled runoff water flowing down intermittent creeks from the foothills.

The acreages of those crops important in the Coalinga areas, as well as the number of fruit trees and grapevines, are given in table 2 for Fresno County as a whole. Census figures for the Coalinga area itself are not available, but the last column of table 2 gives a percentage estimate of crop acreages in the Coalinga area in relation to the total crop acreage in the country.

The prevailing methods of cultivation, yields, pests, and other information concerning principal crops of the Coalinga area are presented in the order of their importance in the following paragraphs. Much of the information was obtained directly from farmers, some by observation during the soil survey.

BARLEY

Barley, the principal grain crop of the area, has been supplanted to some extent by flax, a more profitable crop. Barley yields are highest on loam and clay loam soils of the recent alluvial fans, but good yields have been obtained over a wide range of soil textures and also on soils containing slight concentrations of alkali.

A 12- to 18-inch irrigation is applied before planting barley in November, and this moisture, combined with the winter rains, generally matures the crop by May or June. The preirrigation may have to be supplemented by a shallow check irrigation in March if winter rains have been unusually light. Yields are consistently high if the land is summer fallowed every other year and a cover crop of fenugreek or clover is grown occasionally. Fallowing offsets the bad effects of the relatively high salt content in the irrigation water from wells; cover cropping helps restore nitrogen, which is low in most soils of the area. After fallowing, a rotation including flax or cotton has proved successful.

The common diseases of barley in the area are rusts, smuts, and scald, the last named being the most important. Control of rusts and scald requires use of resistant varieties of seed and crop rotation. Smut can be controlled by pretreating seed with copper carbonate or Ceresan. The area is relatively free from weeds, but morning-glory is rapidly becoming a problem in Pleasant Valley, and yellow starthistle, mustard, and wild oats are scattered throughout the irrigated sections.

FLAX

The first significant commercial growing of flax for seed in California was in 1935. The west side of the San Joaquin Valley has proved exceptionally well suited to it. In the Coalinga area, about 3,089 acres were planted in 1939.

In this area flax is generally preirrigated with a 12- to 18-inch irrigation on the medium- and fine-textured soils and with a 24-inch irrigation on the coarse-textured soils. As soon as the soil can be worked again, usually between October 15 and November 15, it is prepared and seeded by means of a grain or flax drill. The crop is harvested in June or July with combine harvesters. The combine is equipped with rubber rollers if the fields are clean of weeds. If the fields are

weedy, a windrower is often used and is followed by a combine equipped with a pick-up attachment. Sometimes the crop is cut with a binder and threshed with a stationary rig. Crop rotation and fallowing practices similar to those employed in growing barley are considered best for obtaining high yields and quality.

Flax is more susceptible to alkali injury than barley and cannot compete nearly so well with weeds. So far, flax has been little affected by insect pests or diseases in California. Mildew has caused some damage during relatively wet years, but such years are exceptional.

COTTON

All of the cotton grown is of the Acala variety (pl. 1, *B*), developed at the United States Cotton Field Station at Shafter. This early maturing heavy-yielding variety will produce fibers averaging 1$\frac{1}{16}$ inches in staple length.

After a light preirrigation, the seedbed is prepared and the seed drilled in rows 38 or 44 inches apart. Planting is usually completed by April 30. When the plants are 8 to 10 inches tall, they are thinned in rows to stand about 10 inches apart. During the summer, about five light irrigations are applied to make a total of about 3½ acre-feet of water applied to the crop. Coarse-textured soils require slightly more water and fine-textured soils a little less. Harvesting is started in October and continued through January if weather permits. Cotton is ginned in the area and trucked to nearby markets for distribution to manufacturing centers.

Cotton is moderately tolerant of alkali and thrives on a wide range of soil textures. No serious pests are in this area, but some losses occur from grasshoppers, spiders, and thrips. Morning-glory is an especially damaging weed if it is allowed to spread through a field.

GRAIN SORGHUM

Grain sorghum is not extensively grown in this area but is a profitable crop in a rotation with cotton. Double Dwarf Yellow milo and Dwarf White durra (Dwarf White Egyptian corn) give the best yields, averaging about 2,000 pounds or more an acre.

A light preirrigation is usually applied before planting in May or June, and four 6-inch irrigations are usually applied during summer for a total of 2½ acre-feet of water. The seed is usually drilled in rows 36 to 42 inches apart with an ordinary two-row corn or bean planter. The crop is harvested during September and October.

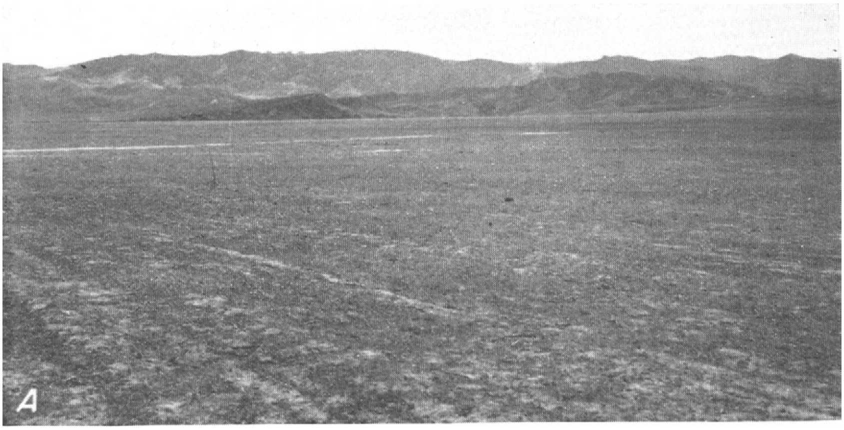
In some cases before planting, the seed is treated with copper carbonate dust to control smut. Weeds, such as morning-glory and Russian-thistle, are particularly damaging.

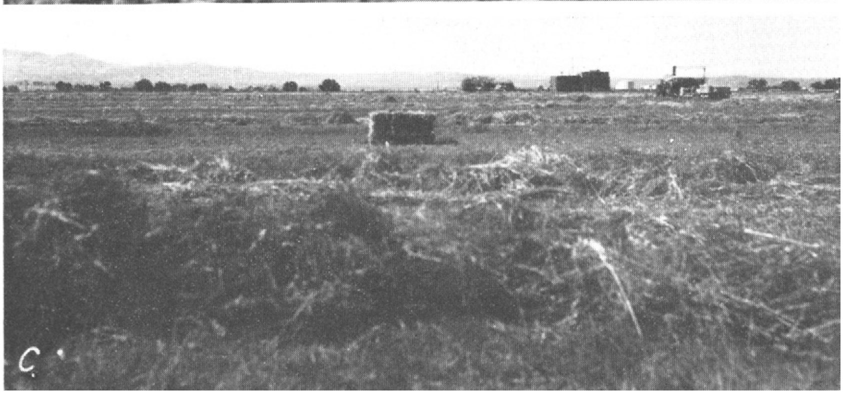
ALFALFA

Alfalfa is grown in Pleasant Valley for local dairy stock (pl. 1, *C*). A few small fields are located along Fresno Slough. The crop is fed locally to livestock. Yields vary considerably from year to year because farmers give the crop no particular attention and make no consistent effort to control pests.

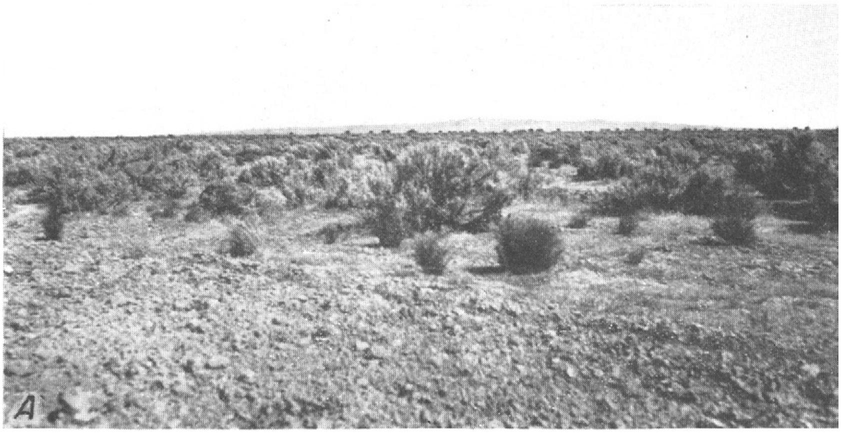
VEGETABLES

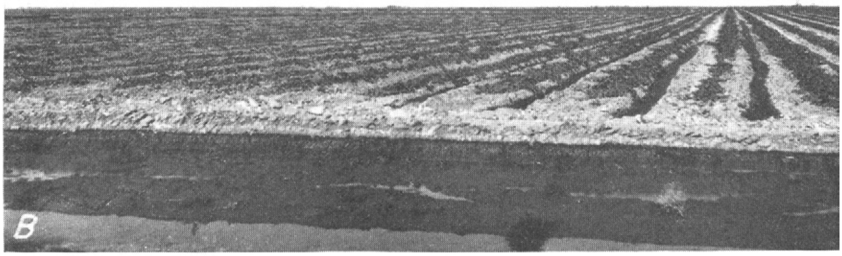
Truck crops, such as spinach, carrots, cabbage, potatoes, onions, and winter peas, are well adapted to this area. In most instances the

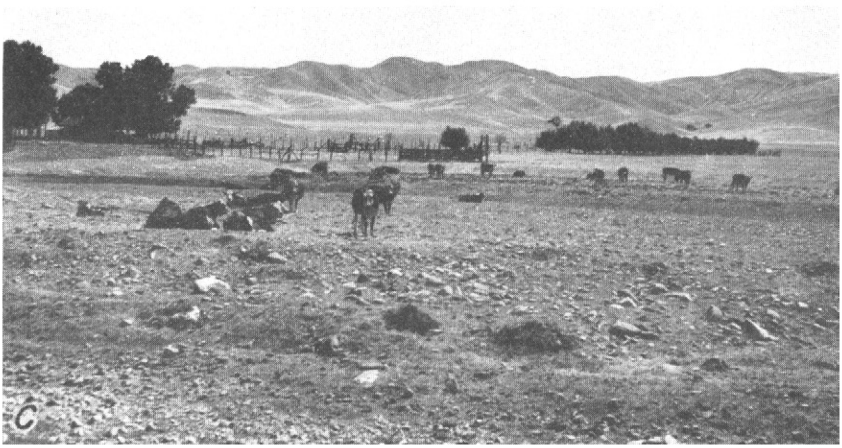




A, Characteristic treeless landscape: Alluvial fan in foreground occupied by Panoche soils; Coast Range in distance; lower hills occupied mainly by Kettleman soils.
B, Young crop of Acala cotton on Panoche clay loam soils; spotted growth caused by improper seeding.
C, Hay baling equipment in hayfield on Panoche loam soils near Coalinga.







A, Atriplex shrubs on Levis silty clay, nearly level, strong alkali.
B, Recently irrigated watermelons on Panoche fine sandy loam, very gently sloping.
C, Range cattle on Riverwash in bed of Los Gatos Creek; bench in middle ground occupied by Ortigalita soils; Kettleman soils on hills in distance.

better soils are selected, and the crop yields and quality compare favorable with those in established truck-crop centers. In view of the initial success of vegetables in this area, it is probable that their acreage will continue to increase. There is much good land available, and if better irrigation water is supplied, there should be no serious limitations to winter and spring crops. Summers, however, are too hot for many vegetable crops.

MELONS

Most of the melons grown are cantaloups and honeydews, although some Persian melons and watermelons are grown. Yields are good, but quality, except for watermelons, is slightly below the standard established in melon-growing centers of the State.

PASTURE

Most land in the Coalinga area not in oil fields or cultivated is pastured if it will produce a good stand of grass. The quantity and quality of unirrigated, or natural, range pasture on the broad alluvial fans and uplands depend on seasonal distribution of rainfall. The carrying capacity does not exceed an animal unit (five or six head of sheep) to 8 or 10 acres under the most favorable spring conditions. Except for a few enclosed pastures and sheep pens on scattered ranches, the range is not fenced. Few seeded and irrigated pastures have been developed.

LIVESTOCK

A few dairy and some beef cattle are raised within the area, but sheep are the main livestock. Sheep can survive in the arid climate and on the sparse forage. Several large bands are herded on the plains and lower foothills in spring. The profit comes mainly from spring lambs and wool. Almost all of the slaughtering is done at Fresno, San Francisco, or Los Angeles.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field (*4*). The soil scientist walks over the area at intervals not more than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each boring or hole shows the soil to consist of several distinctly different layers, called horizons, which are known collectively as the soil profile. Each of these layers is studied carefully for the physical and chemical characteristics that affect plant growth.

The color [5] of each layer is noted. The darkness of the topmost layer is usually related to its content of organic matter; streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration. Texture, or the content of sand, silt, and clay in each layer, is determined by the feel and is checked by mechanical analysis in the laboratory. Texture has much to do with the quantity of moisture the soil will hold available to plants, whether plant nutrients or fertilizer will be held by the soil in forms

[5] Soil color designations used in this report conform to standards proposed by the Division of Soil Survey in 1946.

available to plants or will be leached out, and how difficult the soil may be to cultivate. Structure, or the way the soil granulates, and the quantity of pore or open space between particles indicate how easily plant roots can penetrate the soil and how easily water enters it. Consistence, or the tendency of the soil to crumble or to stick together, indicates how difficult it is to keep the soil open and porous under cultivation.

The kind of rocks and the resulting parent material from which the soil has been developed affect the quantity and kind of plant nutrients the soil may contain.

Simple tests show how acid or alkaline the soil may be[6] and its content of lime and soluble salts.[7] The depth to bedrock or to compact layers is determined. The quantity of gravel or rocks that may interfere with cultivation, the steepness and kind of slope, the quantity of soil lost by erosion, and other external features are observed.

On the basis of all these characteristics, soil areas much alike in the kind, thickness, and arrangement of layers are mapped as one soil type. Soil types that possess a wide range of characteristics are mapped in two or more units. For example, if a soil type has slopes that range from 1 up to more than 30 percent, the type may be mapped in five units—gently undulating (1- to 3-percent slopes), undulating (3- to 7-percent slopes), rolling (7 to 15 percent), hilly (15 to 30 percent), and steep (30+ percent). In addition, a soil type that has been eroded in places or contains alkali may be mapped in two or more units according to degree of erosion or content of alkali. A soil type will be divided into two or more units primarily because of differences in the soil other than those of kind, thickness, and arrangement of layers. The slope of a soil, the extent of erosion, and the degree of soluble salt (alkali) concentration are examples of characteristics that might cause a soil type to be divided into units.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture, especially of the surface layer, will differ. As long as the other characteristics of the soil layers are similar, these soils are considered to belong in the same soil series. A soil series, therefore, consists of all the soil types that have about the same kind, thickness, and arrangement of layers, except for texture, particularly of the surface layer, whether the number of such soil types be only one or several.

The name of a place near where a soil series was first found is frequently chosen as the name of the series. Thus, Panoche is the name of an important deep, permeable, calcareous gently sloping soil series found on recent alluvial fans in the Coalinga area. Six types of the Panoche series are found—Panoche clay loam, Panoche

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[6] The reaction of the soil is its degree of acidity or alkalinity, expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[7] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline (basic) reaction. Lime (calcium carbonate) is detected by hydrochloric acid. Calcareous means containing lime in sufficient quantity to be detected by the application of dilute hydrochloric acid. Noncalcareous means not containing lime in sufficient quantity to be so detected. A soil may contain an abundance of available calcium and yet not be calcareous in the foregoing sense.

loam, Panoche fine sandy loam, Panoche silty clay, Panoche silty clay loam, and Panoche sandy loam. These differ in the texture of the surface soil, as their names show. Panoche fine sandy loam is divided into three units because some of it is very gently sloping, some is gently undulating, and some that is very gently sloping is affected by slight alkali concentrations.

The dominant slopes of the very gently sloping units fall from 0 to less than 3 feet in 100 feet of distance and are simple slopes having generally one direction; whereas those of the gently undulating unit fall more than 1 to less than 3 feet in 100 feet of distance and are complex slopes having more than one direction.

When very small areas of two or more kinds of soil are so intricately associated they cannot be shown separately on a map of the scale used, they are mapped together, and the areas of the association are called a soil complex. Kettleman-Linne complex is mapped in the Coalinga area.

Areas as sand and gravel bars of stream beds or other areas that have little true soil are not designated with series and type names but are given descriptive names, such as Riverwash and Oil-waste land.

The soil type, or where the soil type is subdivided, the soil unit, is used for the mapping of soil surveys. It is the unit, or the kind of soil, that is most nearly uniform and has the narrowest range of characteristics. For this reason land use and soil management practices can be more definitely specified for it than for broader groups of soils that contain more variation. One can say, for example, that soils of the Panoche series require irrigation for production of cultivated crops; but Panoche clay loam, very gently sloping, has long smooth slopes that are relatively easy to irrigate, whereas Panoche clay loam, gently undulating, has an uneven or hummocky surface that requires more than the usual degree of leveling to prepare it for irrigated farming. Both are in the Panoche series.

SOILS

Most of the dominant and characteristic soils of the arid west side of the San Joaquin Valley are represented in the Coalinga area. The early San Joaquin Valley reconnaissance soil survey (*1*) covers most of the area, and an older survey of eastern Fresno County (*9*) includes a small part along the eastern boundary. The present survey has been made in more detail and on a larger scale than the earlier surveys, and consequently several more soil series appear on the soil map. A few soil series and types appearing on the older maps are replaced or further separated, and the alkali conditions are delineated in more detail. Changes in concepts of soil morphology and classification have been brought about through the gradual accumulation of new facts over a period of years.

SOIL SERIES AND THEIR RELATIONS

Two cross-sections of the area—one 2 miles south of the northern boundary and the other in township 20, south, about 2 miles north

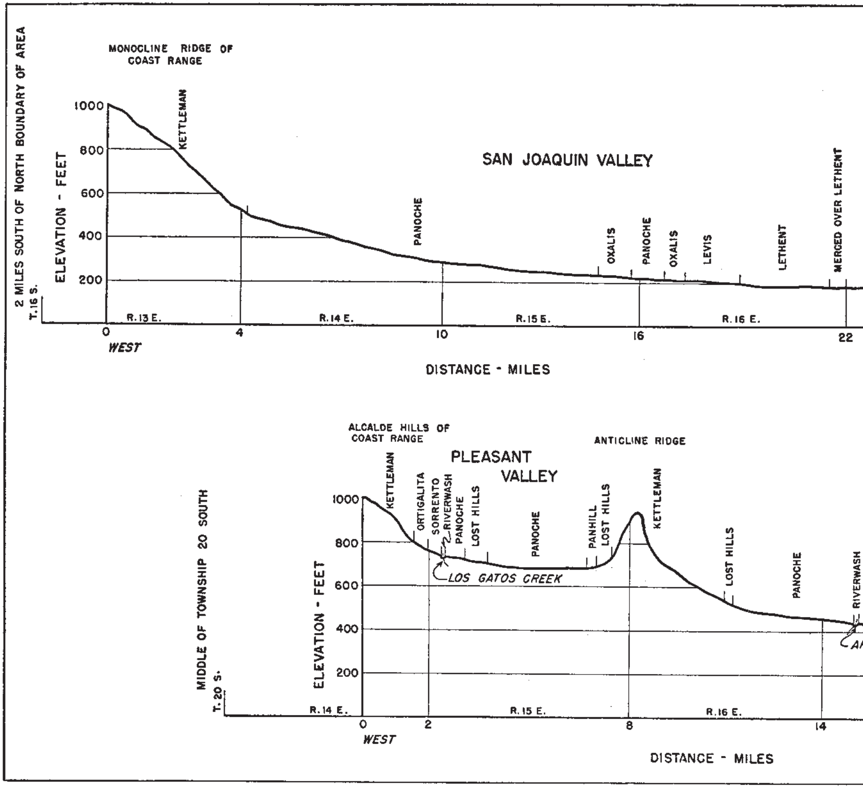

FIGURE 3.—Cross-sections of the Coalinga area, Calif., showing relation

of Coalinga—show important soil relations (fig. 3). Because of the difference between horizontal and vertical scales, slopes are greatly exaggerated on the figure. The relations and associations of the various soil series on the foothills, old alluvial fans, and the broad recent alluvial fans are not particularly complex. The wide range in texture of soils on the recent alluvial fans, however, gives rise to a complex pattern of soil types. In the basin and semibasin areas some of the soils are separated with difficulty because they have many similar characteristics and few distinct ones of their own. In many instances a soil boundary appearing on the map represents the approximate center of a fairly broad transition between two similar soils.

The soils of the area are related in such a manner that they may be placed into natural groups or divisions. For convenience in further discussion, the soils are therefore placed in five main groups that closely follow the natural physiographic divisions of the area (fig. 4). Group 1 includes soils developed in place on underlying consolidated bedrock materials (soils of the hilly uplands); group 2, soils developed on old alluvial fan materials; group 3, soils of recent alluvial fans; group 4, soils of the valley basin rim (slowly drained soils with excess soluble salts); and group 5, soils of the valley basin (dark-colored slowly drained soils with periodic high water table). The soils within each group have many profile characteristics in common and are closely related as to mode of formation and stage of profile development.

SOILS DEVELOPED IN PLACE ON UNDERLYING CONSOLIDATED BEDROCK MATERIALS (SOILS OF THE HILLY UPLANDS)

The soils developed in place on underlying consolidated bedrock materials (soils of the hilly uplands) are in the Kettleman and Linne series and are derived from calcareous sandstone and shale. The Kettleman soils occupy the hilly region, except in one area where there is a complex of Kettleman and Linne soils. The Kettleman soils are characterized by a light brownish-gray shallow and highly calcareous profile. They are usually moderately eroded. Steep slopes are considerably gullied and almost bare of vegetation, whereas gentle slopes have a better stand of grass or low brush and are less eroded. The Linne soils, occurring only in the Kettleman-Linne complex, are darker than the Kettleman but similar in other respects. In the Coalinga area, the Linne soils are derived from a gray calcareous shale deposit that was uplifted and eroded to form an irregular topography.

SOILS DEVELOPED ON OLD ALLUVIAL FAN MATERIALS

The well-drained Lost Hills and Ortigalita series have developed on old alluvial fan materials. They occur on short steep old alluvial fans lying at the base of foothills. They have well-defined subsoils and somewhat leached surface soils.

The Lost Hills soils[8] have grayish-brown generally noncalcareous surface soil with slightly hummocky microrelief. Their upper sub-

[8] In the reconnaissance survey of the Middle San Joaquin Valley (*1*), these soils were included with the Antioch series, which now has been redefined to include a narrower range of soil characteristics.

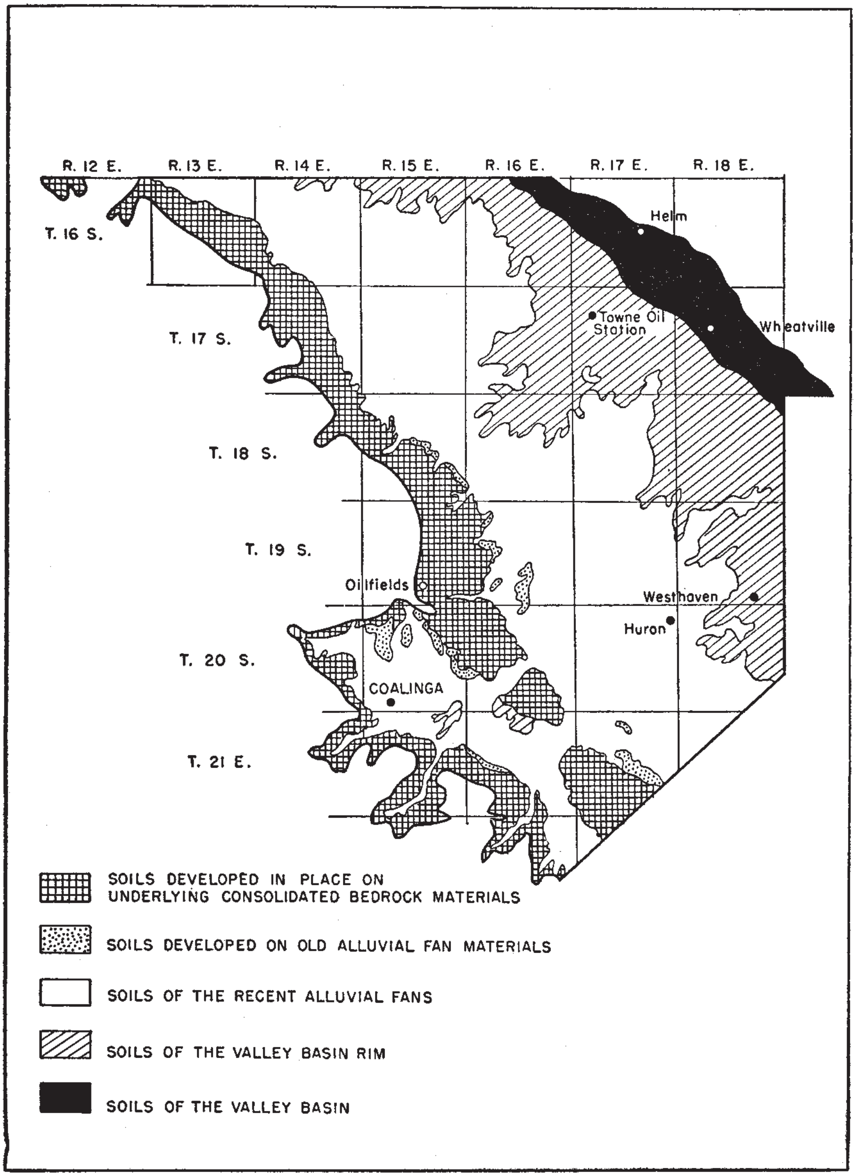

FIGURE 4.—Location and extent of the five main soil groups in the Coalinga area, Calif.

soil is calcareous and pale brown or light yellowish brown. The lower subsoil is brown or pale brown, calcareous, and moderately compact. These are the dominant characteristics of the Lost Hills soils mapped in the Coalinga area; they are not exactly typical of the series as mapped in other surveys, because in this area the upper subsoil is friable and thicker than normal. The Lost Hills soils occur on alluvium derived wholly from light brownish-gray Kettleman soils.

The brown Ortigalita soils [9] have a hummocky microrelief and noncalcareous moderately friable surface soil. The upper and lower subsoils are light yellowish brown, calcareous, and moderately compact, but the lower subsoil contains appreciable quantities of segregated lime. The soil is derived from alluvial material that originated partly in areas of hard somewhat metamorphosed rocks.

SOILS OF RECENT ALLUVIAL FANS

The Panoche, Panhill, and Sorrento soils have formed on recent alluvial deposits and cover more than half of the area surveyed. They have several characteristics in common but also have distinctive individual properties.

The Panoche soils, the principal soils of this group, are characterized by uniform profiles but include a wide range of texture. They are light brownish gray, calcareous, friable, and permeable throughout. They have smooth surfaces on very gently sloping fans of recently deposited alluvium. The source of this alluvium is principally the softly consolidated calcareous and gypsiferous sandstone and shale on the eastern slopes of the Coast Range.

Panoche soils are generally free of alkali or only slightly affected, although a few areas have moderate concentrations. They are associated with the more strongly developed Panhill soils and generally occur closer to the hills and in association with the slowly drained Oxalis soils at the outer edges of the fans and on the basin rim. In large part the Panoche soils are cultivated. They are very productive under irrigation; and as more water for irrigation is made available, the cultivated acreage should increase.

The Panhill soils [10] are similar to the associated Panoche, but they are noncalcareous or very slightly calcareous in the surface soil. They are also slightly older in stage of profile development, as is shown by their definite zone of lime accumulation in the upper subsoil. Normally, Panhill soils occupy slightly older alluvial fans between the hills and the valley trough and are characterized by a very gently sloping slightly hummocky surface. Erosion is slight because the low annual rainfall and the runoff from the uplands is readily absorbed. Most areas are free of alkali, but a few have slight concentrations. Natural vegetation consists of a wide variety of short annual range grasses mixed with a scattering of desert shrubs. The Panhill soils are also associated with the Lost Hills soils of the old alluvial fans. Their parent materials are similar, but the Lost Hills soils are older in stage of profile development. Many Panhill soil areas are suited to irrigated farming, but except for some areas, chiefly in Pleasant Valley, water is not now available.

The Sorrento soils [11] have brown noncalcareous surface soil and friable yellowish-brown calcareous subsoil. They occur on recent alluvial materials washed principally from areas of hard, and in some places

[9] The Ortigalita soils were included mainly in the Pleasanton series in the reconnaissance survey of the Middle San Joaquin Valley (*1*). The Pleasanton series, now more narrowly defined, does not occur in the Coalinga area.

[10] In the reconnaissance survey of the Middle San Joaquin Valley (*1*), the Panhill soils were included with the Panoche soils.

[11] The Sorrento series in this area was included with the Panoche series in the reconnaissance survey of the Middle San Joaquin Valley (*1*).

metamorphosed, sedimentary rocks. Typically, the Sorrento soils have smooth nearly level relief, but in this area they are somewhat more sloping and have a slightly hummocky microrelief. The natural vegetation is short annual grasses that normally afford fair pasture for sheep. Erosion is slight or negligible, mainly because the low annual rainfall is readily absorbed. Alkali is not present. Associated with these soils are the Panhill soils and the older and more fully developed Ortigalita soil of the old alluvial fans. Most areas of Sorrento soils are suitable for irrigated farming if properly leveled, but at present they are not farmed because irrigation water is lacking.

SOILS OF THE VALLEY BASIN RIM (SLOWLY DRAINED SOILS WITH EXCESS SOLUBLE SALTS)

The fine-textured Oxalis, Levis, and Lethent series [12] typically contain an excess of soluble salts and some concentration of gypsum. They occur on the outer edges of alluvial fans bordering the dark soils of the valley basin. Their parent material consists almost entirely of alluvium that originated in areas of softly consolidated calcareous sandstone and shale upon which the Kettleman soils have developed. The soils are not affected by a natural high water table, but surface runoff is slow and salts have concentrated mainly from saline floodwaters.

The Oxalis soils occur on the outer parts of alluvial fans at slightly lower elevations than the Panoche soils. They commonly occur between the higher Panoche and the lower lying Lethent or Levis soils. Oxalis soils are typically somewhat darker than the Panoche, and in general they have higher concentrations of gypsum and soluble salts.

The Levis soil is similar to the Panoche, but it normally contains high concentrations of soluble salts and gypsum. The scant natural vegetation consists entirely of alkali-tolerant weeds and low brush.

The Lethent soils are at about the same stage of development as the Lost Hills and might properly be included with the group of soils on old alluvial fan materials. For the most part, they are capable of supporting only a cover of halophytic plants, as saltgrass and a scattering of alkali-tolerant Atriplex shrubs.

SOILS OF THE VALLEY BASIN (DARK-COLORED SLOWLY DRAINED SOILS WITH PERIODIC HIGH WATER TABLE)

The dark soils of the valley basin, the Merced and Temple series, are imperfectly to poorly drained. They are subject to periodic flooding under natural conditions and have a recurrent high water table. Because of more moist conditions than existed for the well-drained soils of the area, these soils supported a more luxuriant growth of plants and consequently have a higher content of organic matter in the surface soil. Alkali content in the Merced soils is slight or absent and confined generally to the subsoil; in the Temple soils there are no significant concentrations.

The Merced soils are dark gray, fine textured, and have well-defined subsoil structural units. They have developed on alluvium derived from mixed granitic and sedimentary rocks. Reaction of the surface

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[12] The soils of these series were included with the Panoche series in the reconnaissance survey of the Middle San Joaquin Valley (*1*).

soil is neutral or slightly basic. The upper subsoil usually contains segregated lime in the form of small specks and soft concretions, and the lower subsoil is highly calcareous.

The Temple soils are also dark gray, but they have a higher organic-matter content and are moderately friable even in the finer textures. They are derived from mixed granitic and sedimentary rock alluvium deposited adjacent to the main drainage channels of the valley trough. The surface soil is nearly neutral in reaction, the upper subsoil is intermittently calcareous, and the lower subsoil is distinctly calcareous.

SOIL DESCRIPTIONS

In the following pages the soil types and mapping units of the area, identified by the same symbols as those used on the map, are placed in alphabetical order by soil series or miscellaneous land type name and separately described. First given is a general description of the soil type, and then following, a short description of the units into which this type has been divided for mapping. The relations and agricultural importance and adaptations of the soils are discussed. Their distribution is shown on the soil map in the envelope inside the back cover page, and their acreage and proportionate extent are given in table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in the Coalinga area, Calif.*

Soil	Acres	Percent
Kettleman clay loam:		
Hilly, eroded	4, 433	1. 2
Rolling	5, 327	1. 4
Steep, eroded	7, 552	2. 1
Undulating	1, 330	0. 4
Kettleman fine sandy loam:		
Gently sloping	185	. 1
Gently undulating	652	. 2
Hilly, eroded	2, 176	. 6
Rolling	4, 414	1. 2
Steep, eroded	657	. 2
Undulating	2, 976	. 8
Kettleman-Linne complex:		
Hilly, eroded	1, 786	. 5
Rolling	1, 438	. 4
Steep, eroded	915	. 2
Kettleman loam:		
Gently undulating	81	(1)
Hilly, eroded	8, 904	2. 4
Rolling	3, 979	1. 1
Steep, eroded	4, 322	1. 2
Undulating	2, 165	. 6
Kettleman sandy loam:		
Gently undulating	47	(1)
Hilly, eroded	492	. 1
Rolling	441	. 1
Steep, eroded	936	. 2
Undulating	1, 208	. 3
Kettleman silty clay loam:		
Rolling	221	. 1
Undulating	190	. 1

[1] Less than 0.1 percent.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in the Coalinga area, Calif.*—Continued

Soil	Acres	Percent
Lethent silty clay:		
Nearly level, moderate alkali	3, 854	1. 0
Nearly level, moderately strong alkali	2, 528	. 7
Nearly level, slight alkali	362	. 1
Nearly level, strong alkali	17, 909	4. 9
Lethent silty clay loam:		
Hummocky, moderate alkali	154	(1)
Hummocky, slight alkali	265	. 1
Nearly level, moderate alkali	1, 186	. 3
Nearly level, slight alkali	2, 944	. 8
Nearly level, strong alkali	901	. 2
Levis silty clay, nearly level, strong alkali	3, 697	1. 0
Lost Hills clay loam:		
Gently undulating	355	. 1
Undulating	312	. 1
Very gently sloping	1, 075	. 3
Lost Hills fine sandy loam:		
Gently undulating	261	. 1
Undulating	1, 210	. 3
Very gently sloping	632	. 2
Lost Hills loam:		
Gently sloping	135	(1)
Very gently sloping	1, 091	. 3
Merced clay (adobe):		
Nearly level	2, 883	. 8
Nearly level, moderately strong alkali	1, 427	. 4
Nearly level, slight alkali	11, 565	3. 2
Merced clay loam, nearly level, spotted alkali	193	. 1
Merced silty clay loam, shallow over Lethent silty clay:		
Nearly level, moderately strong alkali	586	. 2
Nearly level, spotted alkali	1, 812	. 5
Oil-waste land	332	. 1
Ortigalita clay loam, gently undulating	997	. 3
Oxalis silty clay:		
Nearly level, moderate alkali	8, 316	2. 3
Nearly level, slight alkali	45, 250	12. 4
Panhill clay loam:		
Gently undulating	970	. 3
Very gently sloping	1, 324	. 4
Panhill fine sandy loam:		
Gently undulating	2, 842	. 8
Very gently sloping	2, 547	. 7
Panhill loam:		
Gently undulating	1, 445	. 4
Very gently sloping	1, 767	. 5
Very gently sloping, slight alkali	211	. 1
Panhill sandy loam:		
Gently undulating	839	. 2
Very gently sloping	2, 709	. 7
Panoche clay loam:		
Gently undulating	3, 153	. 9
Very gently sloping	53, 319	14. 6
Very gently sloping, moderate alkali	440	. 1
Very gently sloping, slight alkali	10, 550	2. 9
Panoche fine sandy loam:		
Gently undulating	10, 746	2. 9
Very gently sloping	26, 159	7. 1
Very gently sloping, slight alkali	138	(1)

Less than 0.1 percent.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in the Coalinga area, Calif.*—Continued

Soil	Acres	Percent
Panoche loam:		
Gently undulating	4,087	1.1
Very gently sloping	36,180	9.9
Very gently sloping, spotted alkali	562	.1
Panoche sandy loam:		
Gently undulating	1,992	.5
Very gently sloping	873	.2
Panoche silty clay:		
Very gently sloping	9,629	2.6
Very gently sloping, moderate alkali	103	(1)
Very gently sloping, slight alkali	15,082	4.1
Panoche silty clay loam:		
Very gently sloping	3,702	1.0
Very gently sloping, slight alkali	1,004	.3
Riverwash	2,140	.6
Sorrento clay loam, gently undulating	132	(1)
Sorrento fine sandy loam, gently undulating	34	(1)
Sorrento gravelly clay loam, gently undulating	254	.1
Temple loam, nearly level	143	(1)
Temple silty clay, nearly level	1,724	.5
Temple silty clay loam, nearly level	221	.1
Total	366,080	100.0

[1] Less than 0.1 percent.

KETTLEMAN LOAM

Kettleman loam is the most extensive type of the Kettleman series mapped in the area. It occurs in scattered bodies throughout the foothill section in close association with the other Kettleman types. The slope range is wide, but for the most part the relief is rolling to hilly. The soil has developed in place from underlying softly consolidated calcareous sedimentary rocks that in places contain some seams of gypsum.

Vegetation is mostly short annual grasses, with a few scattered shrubs on some of the steeper slopes. The grasses begin growing in December and continue until May when the rainy season normally ends. Surface runoff varies, depending upon the slope, but generally is excessive because of intense rains of short duration and a sparse vegetative cover.

The separations of Kettleman loam according to differences in slope and erosion are the gently undulating; undulating; rolling; hilly, eroded; and steep, eroded units.

Profile description.—Because of only slight profile development, there is little difference between the surface soil and subsoil. The surface soil is light brownish-gray calcareous friable loam 8 to 10 inches or more deep. It is low in organic matter and has a weakly developed soft blocky structure. The subsoil is light brownish-gray or light yellowish-brown highly calcareous loam that is very slightly compact but easily penetrated by grass roots and water.

At a depth normally ranging from 12 to 40 inches is yellowish-brown or light yellowish-brown partly disintegrated soft sandstone that

contains a considerable quantity of lime and some crystalline gypsum. The sandstone material is more consolidated, less calcareous, and generally grayer at lower depths. The gypsum may be in part responsible for the formation of gullies that are characteristic of some areas.

In some places, slick spots, the result of some salt accumulation, occur at the base of slopes. These spots are generally badly eroded.

Use and management.—Kettleman loam is used almost exclusively for sheep range in conjunction with other Kettleman types, and in general it is best suited to this use. Intensity of use and proper management practices are largely dependent upon slope and degree of erosion.

Kettleman loam, gently undulating (Ko).—The gentle slopes (3-percent or less gradient) of this soil apparently have prevented erosion, and consequently a deeper soil has formed than in the more sloping areas of Kettleman loam. In some places, small increments of soil material have been received from steeper and somewhat eroded soils lying above. Softly consolidated calcareous sandstone, which generally underlies Kettleman loam, occurs at a depth of 35 to 40 inches.

The soil produces a relatively good stand of range grass during normal years, and several months of sheep pasture are provided. The grazing capacity is about one sheep per 1½ or 2 acres for a 5-month season. This soil is less susceptible to erosion and has a somewhat higher carrying capacity for sheep than the more sloping areas of Kettleman loam. It is similar to the gently undulating areas of Kettleman sandy loam and Kettleman fine sandy loam, but it has a somewhat higher moisture-holding capacity.

Kettleman loam, undulating (Ks).—Relief of this soil is uneven or undulating (3- to 7-percent gradient). Erosion is negligible, and a relatively good depth of soil has developed from the underlying sandstone parent material that normally occurs at a depth of about 30 inches. The soil is similar to undulating areas of Kettleman sandy loam and Kettleman fine sandy loam, although its moisture-holding capacity is somewhat higher. Pasture-carrying capacity for sheep is about the same as for gently undulating areas of Kettleman loam, but somewhat more care is necessary to prevent overstocking, depletion of the grass cover, and consequent erosion.

Kettleman loam, rolling (KQ).—This soil occupies a series of rolling hills having dominant slopes of 7 to 15 percent. It occurs throughout the foothill area in close association with other Kettleman soils. Sheet erosion is negligible or very slight, but gully erosion has occurred in some places. Soft sandstone parent material is at a depth of about 20 inches. Short annual grasses provide fairly good sheep pasture for a few months late in winter and in spring. The carrying capacity is one sheep per 1½ to 2½ acres for the grazing season, the actual capacity depending largely on growing conditions. Because it has steeper slopes, more care is needed in grazing sheep on this soil than on the undulating Kettleman soils.

Kettleman loam, hilly, eroded (KP).—In many places erosion has removed most of the surface soil of this unit, and occasional deep gullies have formed. In these eroded areas, the exposed surface soil

is yellowish-brown or light brownish-gray highly calcareous slightly compact loam. The surface soil is slightly less permeable than normal, and the soft sandstone parent material lies at a shallow depth of 10 to 16 inches. Slopes range from 15 to 30 percent. Areas occur throughout the foothill section in close association with Kettleman sandy loam, hilly, eroded; and Kettleman fine sandy loam, hilly, eroded.

The grass cover is relatively sparse; its carrying capacity for sheep is low, or about one sheep for 3 to 5 acres through the grazing season. Erosion has been caused chiefly by intensive grazing. Eroded areas are difficult to restore, but no doubt some restoration would take place if they were lightly grazed over a long period of years.

Kettleman loam, steep, eroded (Kr).—Slopes on this soil are usually greater than 30 percent. Most of the surface soil has been removed by erosion in many places, and gullies have formed in small drains. The exposed surface soil is light yellowish-brown or light brownish-gray highly calcareous loam similar to the subsoil in uneroded areas. Soft sandstone parent material normally occurs at a depth less than 16 inches.

This soil has a sparse cover of short annual grasses and in a few places some low shrubs. Some of the land is used for sheep pasture, but most of it is too steep and sparsely vegetated to be of much use even for grazing. More than 6 acres per sheep are required for the grazing season. Overgrazing in the past has been the principal cause of erosion, and because of dry climate, relatively intense rains, and steep slope, it is doubtful that significant restoration of eroded areas can be accomplished.

KETTLEMAN CLAY LOAM

Kettleman clay loam occurs throughout the foothill section in close association with other Kettleman soils. Like other types of this series, it has a wide range in slope, but for the most part occurs on rolling to hilly relief. The parent material consists of softly consolidated calcareous shale and fine-grained sandstone that in places may contain seams of gypsum.

The vegetation is almost entirely short annual grasses that begin growing with the winter rains and continue until May when the rainy season normally ends. Surface runoff from hilly and steep areas is great because rains are heavy and of short duration and the vegetation is sparse.

Kettleman clay loam is separated according to differences in slope and erosion as undulating; rolling; hilly, eroded; and steep, eroded.

Profile description.—There is little difference between the surface soil and subsoil. The surface soil consists of light brownish-gray calcareous friable clay loam of low organic-matter content. At a depth of about 12 or 14 inches it grades into heavy loam or clay loam subsoil that is usually light brownish gray or light yellowish brown, highly calcareous, and very slightly compact.

Partly decomposed bedrock of yellowish-brown or light yellowish-brown fine-grained sandstone or shale containing numerous lime seams and some crystals of gypsum is usually encountered at a depth ranging from 10 to 30 inches. This material is more firmly consolidated at lower depths, where it is only slightly calcareous and less yellowish. The occurrence of gypsum may be in part responsible for the forma-

tion of gullies that occur in some places. The parent material in places contains some soluble salts, and slick spots at the base of slopes are indicative of some accumulation of alkali.

Use and management.—As with the other soils of the Kettleman series, Kettleman clay loam is used almost exclusively for sheep range, and in general it is best suited to this use. Proper intensity of grazing on this soil varies considerably with slope and degree of erosion.

Kettleman clay loam, undulating (KD).—This soil has smooth slopes of 3- to 7-percent gradient. Erosion is negligible, and a relatively deep soil has developed from the underlying fine-grained sandstone parent material, which normally occurs at a depth of about 30 inches. This soil is distinctly heavier textured and of higher water-holding capacity than most other undulating Kettleman soils. A fairly good growth of annual grasses occurs late in winter and early in spring and provides pasture that supports about one sheep per 1½ acres for the grazing season. As the season for profitable grazing is short, this soil can be considered only fair for annual grazing.

Kettleman clay loam, rolling (KB).—Although of similar relief (7- to 15-percent gradient), this soil has a higher water-holding capacity than the rolling areas of Kettleman sandy loam, Kettleman fine sandy loam, and Kettleman loam. Sheet erosion is negligible or slight, but gullying has occurred in some places. The frequency of occurrence and depth of the gullies depends mainly on the extent of the watershed lying above. Underlying soft fine-grained sandstone normally occurs at a depth of 20 or 22 inches.

The carrying capacity for sheep grazing is slightly less than for the undulating areas of Kettleman clay loam—about 2 acres per sheep for a 5-month season. Greater care is required in stocking this soil than the less sloping units, and sheep-bedding grounds should not be located on it.

Kettleman clay loam, hilly, eroded (KA).—Most of the surface soil has been removed from this soil in many places, and a 10- to 18-inch layer of grayish-brown or light brownish-gray highly calcareous slightly compact heavy loam or clay loam is exposed. The underlying parent material is partly decomposed yellowish-brown or light yellowish-brown fine-grained sandstone or shale that is calcareous and contains gypsum in places. Areas of this soil occur extensively along the foothills on 15- to 30-percent slopes.

The grass cover is sparse, and sheep pasture is poor. The carrying capacity is one sheep to each 3 or 4 acres for the grazing season. Intensive grazing has been the main cause of erosion, but the heavier texture and higher moisture-holding capacity of this soil might make restoration through deferred and very light grazing more successful than on the lighter textured Kettleman soils.

Kettleman clay loam, steep, eroded (KC).—This soil occupies hilly or steep areas in the foothill section. Slopes are greater than 30 percent, and in many places most of the surface soil has been removed by erosion as a result of overgrazing. The exposed surface is grayish-brown or light brownish-gray heavy loam or clay loam that is slightly compact and highly calcareous. Underlying material, consisting of fine-grained sandstone and shale, occurs at depths of 16 inches or less.

Even during years of favorable rainfall this soil produces only a scant cover of short annual grasses. In a few places the land is used for sheep pasture, but most of it is too steep and barren of vegetation for grazing, and more than 6 acres are required for each sheep. It is not likely that many areas can be restored to a higher productivity for grazing, but it is important that erosion should be reduced where practicable through deferred and very light grazing.

KETTLEMAN FINE SANDY LOAM

Kettleman fine sandy loam occurs in association with Kettleman loam and Kettleman sandy loam on the treeless and rounded slopes of the foothills in the western part of the Coalinga area. The soil occurs on a wide range of slopes, but for the most part relief is undulating, rolling, or hilly. The soil has developed in place from underlying softly consolidated calcareous sandstone, and there is little difference between surface soil and subsoil.

Natural vegetation consists mostly of short annual grasses that begin their growth with the winter rains and continue until the dry season commences in May. As with other types of the Kettleman series, surface runoff is excessive on steeper slopes because dense vegetative cover is lacking and rainfall is of fairly high intensity but short duration.

Kettleman fine sandy loam is separated according to slope and erosion into the following units: gently undulating; gently sloping; undulating; rolling; hilly, eroded; and steep, eroded.

Profile description.—The surface soil is a light brownish-gray calcareous friable fine sandy loam of low organic-matter content. The structure is one of very indistinct medium-sized soft blocks. At a depth ranging from 8 to 18 inches, the surface soil grades into a light brownish-gray or light yellowish-brown very slightly compact highly calcareous fine sandy loam or light loam.

Underlying parent material occurs at a depth normally ranging from 8 to 38 inches and consists of a yellowish-brown or light yellowish-brown softly consolidated sandstone that is calcareous and that may contain crystalline gypsum.

Use and management.—As with other soils of the Kettleman series, Kettleman fine sandy loam is used almost exclusively for sheep pasture, to which it is best suited. Proper use of the soil in connection with grazing is largely dependent upon the degree of slope and the degree of erosion that has occurred.

Kettleman fine sandy loam, gently undulating (Kf).—The profile of this soil is relatively deeper than that of the fine sandy loam on steeper slopes. Slopes are of low gradient (3 percent or less), and apparently they have reduced erosion and allowed the formation of a deeper soil. In addition, small increments of soil material have been received from steeper and somewhat eroded soils lying above. Underlying sandstone parent material normally occurs at depths of 32 to 38 inches. This soil is similar to the gently undulating areas of Kettleman sandy loam, but its moisture-holding capacity is somewhat higher.

A relatively good stand of short annual grasses is produced late in winter and early in spring; 1½ or 2 acres support about one sheep. On an annual basis, however, the carrying capacity can be considered

only fair. Primarily because of gently undulating slopes, this soil is less subject to erosion under intensive grazing than the somewhat steeper areas of Kettleman fine sandy loam.

Kettleman fine sandy loam, gently sloping (KE).—Sheet erosion has been negligible on this soil, and as yet there is no significant gullying. This soil is similar to Kettleman fine sandy loam, gently undulating; it differs mainly in having slightly steeper (3- to 7-percent gradient) but smoother relief. Sandstone parent material occurs at depths of 30 to 36 inches. The natural cover of short annual grasses supplies good sheep forage for a few months late in winter and early in spring. The carrying capacity is similar to that for the gently undulating areas of Kettleman fine sandy loam, but steeper slopes make this soil somewhat more subject to erosion under intensive grazing.

Kettleman fine sandy loam, undulating (KK).—Areas of this soil have an uneven or undulating surface with slopes of 3 to 7 percent. Erosion is negligible, and a relatively good depth of soil has developed from the underlying sandstone parent material, which occurs at an average depth of 30 inches. This soil is similar to Kettleman sandy loam, undulating, and differs mainly in being less coarse in texture and of slightly higher water-holding capacity. It differs from Kettleman fine sandy loam, gently undulating, chiefly in having slightly steeper slope. As with undulating areas of other Kettleman soils, this soil supplies fairly good sheep pasture for a few months.

Kettleman fine sandy loam, rolling (KH).—These soil areas have smooth rounded slopes of 7 to 15 percent. Sheet erosion has been very slight, but some gullying has occurred. Steeper slopes make the erosion hazard for this soil considerably greater than on less steeply sloping areas of Kettleman fine sandy loam. Underlying sandstone parent material occurs at depths of 16 or 20 inches. The soil is similar to Kettleman sandy loam, rolling, and differs mainly in being less coarse in texture and in having a slightly higher water-holding capacity. Short annual grasses provide fairly good pasture for sheep for a few months late in winter and early in spring. The carrying capacity is about one sheep for 2 to 2½ acres.

Kettleman fine sandy loam, hilly, eroded (KG).—In most places the surface soil has been removed by sheet erosion, and deep gullies have formed in a number of places. The general relief is hilly, and the rounded slopes are 15 to 30 percent in gradient. In place of the normal surface soil, a grayish-brown, light brownish-gray, or light yellowish-brown highly calcareous and slightly compact fine sandy loam subsoil is usually exposed. Underlying parent material normally occurs at depths of 8 to 15 inches and consists of partly decomposed yellowish-brown or light yellowish-brown sandstone that is similar to the parent material underlying most areas of Kettleman fine sandy loam soils. In many respects this soil is similar to Kettleman sandy loam, hilly, eroded.

The annual grass cover is thin, and value for grazing is considerably less than for areas of gentler slope and less erosion. The carrying capacity is about one sheep for each 4 or 5 acres for the grazing season. Because of the degree of erosion and the steeper slope, the hazard of further erosion from sheep grazing is high. Although

eroded areas are difficult to restore in this dry climate, some restoration would no doubt take place if grazing were deferred until later in the season and if it were much less intense.

Kettleman fine sandy loam, steep, eroded (Kɪ).—This soil consists of hilly or steep areas with slopes greater than 30 percent. In most places the surface soil has been removed by erosion. The surface layer now exposed is light yellowish-brown or grayish-brown slightly compact highly calcareous fine sandy loam, a part of the subsoil. Soft sandstone bedrock, characteristic of the parent material under other areas of Kettleman fine sandy loam, normally occurs at depths less than 12 inches. This soil is similar to Kettleman sandy loam, steep, eroded.

Even during years of more favorable rainfall this soil is barely covered with a scant growth of short annual grasses. Some of it is used as sheep pasture, but most of it is too steep and barren to be of value. More than 7 acres are needed to pasture one sheep through the grazing season.

KETTLEMAN SANDY LOAM

Kettleman sandy loam is the sandiest soil of the uplands in the Coalinga area. It occupies small areas in the grass-covered round-topped hills in the vicinity of Coalinga and is associated with Kettleman fine sandy loam and Kettleman loam. It has formed in place from underlying softly consolidated calcareous sandstone and has a weakly or slightly developed profile.

The vegetation is dominantly annual grasses that start growing about the first part of December with the beginning of the winter rains and start turning brown in May at the end of the rainy season. The 6 to 8 inches of precipitation is not enough to produce the luxuriant or dense growth of grass needed to prevent sheet and gully erosion. External drainage is excessive on steep areas because of brief heavy rains and scant plant cover.

Five separations of Kettleman sandy loam are mapped—the gently undulating; undulating; rolling; hilly, eroded; and steep, eroded.

Profile description.—The surface soil is light brownish-gray calcareous friable sandy loam of low organic-matter content and weakly developed structure. The soil material is so high in lime that it feels soft, and when saturated it is moved readily by flowing water. The subsoil begins at a depth ranging from 4 to 12 inches or more and consists of light brownish-gray firm highly calcareous sandy loam that is easily penetrated by grass roots.

At a depth ranging from 8 to 40 inches, the subsoil grades into underlying yellowish-brown or light yellowish-brown softly consolidated sandstone that is highly calcareous and that may contain crystalline gypsum. The gypsum may be in part responsible for the formation of gullies that are characteristic of some areas.

In a few places slick spots occur at the base of the steeper slopes. These spots are indicative of alkali and are generally nearly barren and badly eroded. Water penetrates them very slowly. Such areas are much less common in this soil than in heavier textured Kettleman soils.

Use and management.—Kettleman sandy loam is used almost exclusively for sheep range in conjunction with other Kettleman types.

From a physical standpoint, the intensity of use, best management, and highest carrying capacity depend upon slope and erosion.

Kettleman sandy loam, gently undulating (KT).—This soil has slopes of less than 3 percent and is less susceptible to erosion than steeper areas of Kettleman sandy loam. It has a thicker soil mantle (30 to 40 inches) over bedrock than the steeper areas, owing to materials washed from adjacent slopes, deeper soil development, and little or no erosion. It receives supplemental water from runoff.

This soil produces more vegetation than the steeper areas that have shallower profiles and should have a much higher carrying capacity for grazing livestock. If well managed, 1½ to 2½ acres will graze one sheep for the grazing season. If other factors are comparable, sheep should be able to graze longer than on the adjacent steeper areas without causing erosion or deterioration of the vegetation.

Kettleman sandy loam, undulating (KX).—The small areas of this soil have slopes of 3 to 7 percent. Erosion is negligible, and a relatively deep soil of about 30 inches has developed from the underlying parent materials. The carrying capacity for livestock is not so high as on gently undulating areas, but higher than on the steeper areas of Kettleman sandy loam. This soil can be grazed longer than the steeper areas without deterioration of vegetation. One sheep requires about 2 acres for the 4- or 5-month grazing period.

Kettleman sandy loam, rolling (KV).—This soil consists of a series of rolling hills with dominant slopes of 7 to 15 percent. Parent material normally occurs at depths of 12 to 18 inches. Sheet erosion is slight, but gullies have formed and more are forming. The frequency and depth of the gullies depend upon the size and character of the adjacent watershed and the quantity of gypsum in the parent material. This soil is similar to Kettleman fine sandy loam, rolling, but coarser textured and less valuable for grazing.

The carrying capacity for livestock is higher than on the steeper and more eroded areas of the type but not so high as on the more gently sloping areas. About 2 to 2½ acres are required to pasture one sheep during the grazing season.

Kettleman sandy loam, hilly, eroded (KU).—Relief of this soil is hilly (15- to 30-percent gradient). Nearly all of the virgin surface soil has been removed by water erosion, and many gullies have formed. The depth to the underlying parent material, less than 14 inches, is much less than on the more gently sloping areas of Kettleman sandy loam. The exposed surface soil is lighter colored, more compact, slightly heavier, and higher in content of sandstone fragments and shale chips than the surface soil in areas not so steep or eroded. Some areas have some gravel on the surface and throughout the profile. The gravel appears to be from remnants of old terrace material or from conglomerate rocks.

A thin stand of short annual grasses is the only vegetation this soil supports, even during years of more favorable rainfall. Overgrazing by sheep has caused soil deterioration impractical or nearly impossible to correct. When the soil becomes eroded, barren, and exposed to rain, a thin crust forms on the surface that apparently restricts water penetration. As a result, grass roots cannot become established for lack of moisture, erosion becomes more active, and

the area becomes barren. The carrying capacity is low; one sheep requires 4 to 6 acres for the winter and spring grazing periods.

Kettleman sandy loam, steep, eroded (Kw).—Areas of this soil have slopes exceeding 30 percent and are severely eroded. The soil differs from Kettleman sandy loam, hilly, eroded, in being steeper, more severely eroded, shallower to bedrock (less than 10 inches), and of less value for grazing. Other factors for upland soils can be the same, but if slopes are steeper for one soil, it will have greater erosion, a shallower profile, and a lower carrying capacity.

This soil is not so steep that sheep cannot graze, but it has never been very productive. Overgrazing during some of the drier years caused severe sheet and gully erosion that reduced the carrying capacity to one sheep each 8 or 10 acres or more for the 5-month grazing period. Erosion will be exceedingly difficult if not impossible to control. The carrying capacity would be low even if there were little or no accelerated erosion.

KETTLEMAN SILTY CLAY LOAM

Kettleman silty clay loam occurs for the most part in the foothill section on undulating and rolling relief. In the Mendota and Los Banos soil survey areas to the north this type occurs more extensively and on a wider range of relief, much of which is hilly. The soil has developed in place from underlying softly consolidated calcareous shales that in places may contain some seams of gypsum. Like the other Kettleman soils, this soil is only slightly developed, having but slight difference between surface soil and subsoil. Surface runoff is moderate but would be excessive in areas of steeper slope. Short annual grasses comprise most of the natural vegetation. They begin their growth with the start of the winter rains and continue until late spring or the end of the rainy season.

Undulating and rolling areas of this soil have been mapped in the area.

Profile description.—The surface soil is light brownish-gray or grayish-brown friable calcareous silty clay loam about 10 to 18 inches deep. It grades into pale-brown or light yellowish-brown silty clay loam subsoil that contains disseminated lime and a few crystals of gypsum. The subsoil is slightly compact, and there is a faint colloidal staining on the firm generally blocky aggregates.

Softly consolidated yellowish-brown or light yellowish-brown calcareous shale bedrock is usually encountered at depths of 20 to 40 inches. This shale material is less calcareous and more firmly consolidated at lower depths. In places it contains some gypsum, which may be in part responsible for the formation of gullies that are characteristic of some areas of this soil.

In some places, numerous slick spots occur at the base of the steeper slopes and are indicative of alkali. These are generally nearly barren and eroded.

Use and management.—As with other Kettleman soils, Kettleman silty clay loam is used almost exclusively for sheep range. The carrying capacity for sheep grazing is somewhat higher than for other types of the Kettleman series, primarily because heavier texture and higher water-holding capacity favor a somewhat more luxuriant grass

cover. The use and management of this soil for grazing purposes varies largely with slope and erosion.

Kettleman silty clay loam, undulating (Kz).—The relief of this soil is smooth and undulating (3- to 7-percent slopes). Sheet erosion has been negligible, and as yet the extent of gullying has been small. Underlying shale bedrock occurs at an average depth of 30 to 35 inches.

Because of its heavier texture and somewhat higher moisture-holding capacity, this soil produces a denser grass cover than corresponding areas of lighter textured Kettleman soils. Fairly good grazing is provided for a few months late in winter and early in spring, but on an annual basis grazing can be considered only fair because of the long dry summers and the relatively small quantity of vegetation produced each year. About 1½ acres will support a sheep for the 4- or 5-month grazing season.

Kettleman silty clay loam, rolling (Ky).—This soil occurs on a series of rolling hills having slopes of 7 to 15 percent. It shows slight or negligible sheet erosion but some gullying. Softly consolidated shale bedrock occurs at an average depth of 25 inches.

The grass cover is somewhat denser than on lighter textured Kettleman soils of comparable slope because of the heavier texture and higher water-holding capacity. The carrying capacity is about one sheep per 2 acres for the grazing season, but the steeper slopes require that more precaution be taken to prevent erosion than is needed for undulating areas of Kettleman silty clay loam.

KETTLEMAN-LINNE COMPLEX

This complex consists of areas of Kettleman and Linne soils so closely associated that their separation on the soil map was not feasible. Both soils have developed from underlying softly consolidated calcareous sedimentary rock. They occur on rolling to steep relief. Surface runoff is generally excessive because vegetation is sparse and rains are intense and of short duration. The vegetation is mainly short annual grasses, with a few scattered shrubs on some of the steeper slopes.

This complex has been separated on the soil map on the basis of slope and erosion. The units are as follows: Rolling; hilly, eroded; and steep, eroded.

Profile description.—The complex consists primarily of Kettleman clay loam and Linne silty clay. The Kettleman clay loam in the complex corresponds to Kettleman clay loam already described (p. 25). Linne silty clay has a gray or dark-gray calcareous moderately friable silty clay surface soil that is permeable to air, roots, and water. This soil has a low organic-matter content but supports a better growth of grass than the adjacent Kettleman soil, which indicates that it possibly has a higher nutrient level. The surface soil grades into highly calcareous gray clay or silty clay subsoil at an average depth of about 11 inches. The massive subsoil is slowly permeable to roots and water. The underlying parent material, occurring at depths ranging from less than 12 inches to about 20 inches, consists of gray or light-gray calcareous shattered shale rock.

Use and management.—The soils of the complex are used almost exclusively for sheep range in conjunction with soils of the Kettleman series and are best suited to such use.

Kettleman-Linne complex, rolling (Km).—This complex has well-rounded fairly smooth slopes of 7 to 15 percent. Sheet erosion is slight or negligible, but gullying has occurred in a few places. The shale parent material generally occurs at a depth of about 20 inches. The short annual grasses that grow during the rainy season provide some pasture for sheep in spring. Much of this complex is taken up by oil wells or held in oil leases; consequently, little of it is pastured.

Kettleman-Linne complex, hilly, eroded (Kl).—In many places erosion has removed practically all of the surface soil from the soils of this complex. The general relief is hilly, with dominant slopes of 15 to 30 percent. Both sheet and gully erosion, resulting primarily from overgrazing by sheep, have occurred. Shallow and partly altered subsoils are exposed, and shale parent material occurs at depths of less than 20 inches. A thin stand of annual grasses is all that these soils will produce, even during years of above-normal rainfall. A few areas are used to pasture sheep, but a large part is taken up by oil wells and oil leases.

Kettleman-Linne complex, steep, eroded (Kn).—Areas of this complex have slopes greater than 30 percent, and in many places much of the surface soil has been eroded away. Erosion has exposed a thin subsoil material, generally slightly compact and highly calcareous. Shale parent material occurs at a depth of less than 15 inches. These soils produce a scant cover of short annual grasses. Some of the land is pastured to sheep, but most of it is too steep and barren to be of value for grazing. One sheep needs more than 7 or 8 acres during the grazing season.

LETHENT SILTY CLAY

Lethent silty clay occurs in a basin-rim position on the nearly level outer parts of alluvial fans. It typically contains strong concentrations of salts, which are mainly neutral in reaction and of the white-alkali type. The soil developed from fine-textured alluvium derived from the calcareous sandstone and shale of the uplands that give rise to the Kettleman series. There is little runoff because the soil absorbs most of the rain that falls and has slopes of less than 1 percent.

Vegetation consists mainly of alkali-tolerant shrubs and grasses, with Atriplex shrubs predominating. In a few places vegetation is completely lacking; however, where alkali concentrations are not too strong, short annual grasses predominate.

Four different degrees of alkali concentration have been separated on the map; namely, slight, moderate, moderately strong, and strong.

Profile description.—The light brownish-gray or grayish-brown noncalcareous blocky silty clay surface soil extends to an average depth of 8 inches. It can be worked when dry or slightly moist, but when wet it becomes sticky and hard to till.

There is an abrupt change to an upper subsoil of yellowish-brown or grayish-brown calcareous and gypsiferous silty clay of relatively high colloidal content and of moderately well developed prismatic

structure when dry. The lower subsoil, at a depth of about 30 inches, is usually similar in texture but less calcareous than the soil above and contains a relatively large quantity of gypsum. It is yellowish brown or light yellowish brown, contains some colloidal stains, has no definite structure, and is moderately friable. Alkali is generally more concentrated in the lower subsoil than in other layers.

Underlying material occurs at a depth of about 60 inches and consists dominantly of fine-textured calcareous light yellowish-brown alluvium that is in places somewhat stratified with coarser slightly micaceous material.

Use and management.—Since most of Lethent silty clay contains too high a concentration of salts to be cultivated successfully, it is used mainly for sheep grazing. The quality of pasture depends largely on the content of alkali. Where concentrations of salts are relatively low, the soil is farmed successfully.

Lethent silty clay, nearly level, slight alkali (Lc).—Areas of this soil are inextensive, but important because their low alkali content permits successful cultivation of field crops. Under irrigation barley and cotton yield fairly well if the land is occasionally left fallow and nitrogen fertilizer is applied. Deep-rooted crops are not adapted. Because of the fine texture and low permeability of the soil and the type of well water used in irrigation, it is doubtful that the alkali concentration can be reduced very much. Care is required in the handling of irrigation water and in leveling, so as to prevent increasing the concentration of salts in the surface soil, or rooting zone.

Lethent silty clay, nearly level, moderate alkali (La).—This soil is poorly adapted to crops. It is probably best suited to seeded and irrigated pasture if a sufficient supply of cheap water can be developed. Most of the salts are neutral, with sodium sulfate predominating; in a few places, however, the soil contains some sodium carbonate, or black alkali, and has a strongly alkaline reaction. Because the present supply of irrigation water is limited and the soil is heavy-textured, reclamation probably is not feasible. The vegetation consists largely of short annual grasses. Pasture for sheep is provided during a few months late in winter and early in spring. The carrying capacity is about one sheep each 2 acres for the 5-month season.

Lethent silty clay, nearly level, moderately strong alkali (Lb).—Moderate concentrations of alkali are in the surface of this soil, and strong concentrations in the subsoil. This distribution of alkali allows the soil to be used in much the same way as Lethent silty clay, nearly level, moderate alkali; however, it is shown separately on the map because some of the alkali salts in the subsoil may rise to the surface and further restrict the already limited use. This soil is best suited to irrigated pasture consisting of those forage plants adapted to moderately saline conditions and to use for natural sheep range.

Lethent silty clay, nearly level, strong alkali (Ld).—This soil is by far the most extensive and typical of the Lethent series. It has strong accumulations of white alkali, and, in addition, places where small quantities of the more toxic black alkali, or sodium carbonate,

are present. This practically nonagricultural soil has a cover of Atriplex shrubs and some saltgrass. It is limited to sheep grazing; the carrying capacity is low, about one sheep to each 4 to 6 acres for the grazing season. As it is now, the soil is not worth reclaiming, but if water were more abundant and cheaper, partial reclamation through the growing of rice would be feasible.

LETHENT SILTY CLAY LOAM

Lethent silty clay loam does not occur extensively in the Coalinga area and is mapped mostly along the eastern boundary of the area adjoining the Kings County survey. Areas are on the outer edges of the broad alluvial fans in a basin-rim position. In many characteristics the soil is similar to Lethent silty clay. The slope is mainly smooth and nearly level (less than 1-percent gradient), but a few areas have a hummocky microrelief.

Separations of Lethent silty clay loam have been made on the basis of alkali concentration and hummockiness of the surface. These units are the nearly level, slight alkali; nearly level, moderate alkali; nearly level, strong alkali; hummocky, slight alkali; and hummocky, moderate alkali.

Profile description.—The surface soil is light brownish gray or grayish brown, generally noncalcareous, moderately friable, and of silty clay loam texture. It can be worked into a fairly good tilth after the first light rains, but when it becomes thoroughly wet it is very sticky and difficult to till.

At a depth ranging from 8 to 10 inches, the surface soil grades rather abruptly into an upper subsoil that consists of about 11 inches of grayish-brown or yellowish-brown highly calcareous and gypsiferous silty clay or silty clay loam that is only slowly permeable to roots and water. This material has a relatively high colloidal content and gives rise to well-defined prismatic structural units when the soil is dry. When the soil is wet, however, the fine clay particles of this structure run together and form a sticky mass. The lower subsoil, above an average depth of 60 inches, is less calcareous than the soil above, but usually it contains appreciable quantities of crystalline gypsum. It is yellowish brown or light yellowish brown, moderately friable, and of no definite structure.

Underlying material consists for the most part of light yellowish-brown calcareous silty clay loam or silty clay that is in places stratified with coarser slightly micaceous material. Alkali is generally most concentrated in the lower subsoil, and most of it is of the white-alkali type.

Use and management.—Alkali is the principal factor in the use of this soil, although in some places a hummocky surface also determines use.

Lethent silty clay loam, nearly level, slight alkali (LH).—The slight concentration of alkali in this soil is fairly evenly distributed throughout the soil profile and consists almost entirely of neutral salts, or white alkali. The relief is smooth and nearly level, the slope being less than 1 percent. Although the relatively low alkali content makes this soil less typical of the Lethent series, it is regarded as the best Lethent soil for agriculture. Under irrigation, fair crops

of barley and cotton are obtained, particularly where occasional fallowing and nitrogen fertilization are practiced. Orchard crops are not well adapted because of the slight content of alkali and gypsum.

Lethent silty clay loam, nearly level, moderate alkali (LG).—Most of this soil has a moderate content of salts of white-alkali character. In a few places, however, the soil is strongly alkaline and contains a small quantity of black alkali. Relief is smooth and less than 1 percent in slope. The soil is poorly suited to most field crops because of the alkali concentrations, but it is well suited to seeded and irrigated pasture. Barley is successfully grown in some places, but yields are only fair.

Lethent silty clay loam, nearly level, strong alkali (LK).—Strong concentrations of alkali in this soil make it unsuited to crops. The alkali salts are neutral in most places and fairly strongly concentrated throughout the soil profile, although the greatest concentration is usually in the subsoil. A few strongly alkaline places contain some black alkali.

Alkali-tolerant shrubs and grasses comprise the natural vegetative cover. About 4 or 5 acres are needed to graze one sheep during the grazing season. A few fields have been used as permanent irrigated pasture, but in general this soil is not well suited to such use because of high salt concentration. Although the smooth surface of less than 1-percent gradient is favorable for irrigation, the present water supply probably would not make reclamation worth while. If ample water were assured, partial reclamation through rice growing would likely be feasible.

Lethent silty clay loam, hummocky, slight alkali (LF).—This soil occurs where coarse-textured material from nearby Panoche soils has been unevenly deposited over Lethent silty clay loam, has become fairly well stabilized, and has left a hummocky microrelief. The hummocks, or mounds, are irregularly spaced and rise 18 inches or less above the general level of the surrounding land. These hummocky areas may be remnants of a former more extensive area of wind-deposited material and are easily leveled. Where they are leveled, the soil is farmed and managed in much the same way as Lethent silty clay loam, nearly level, slight alkali. Fair yields of cotton and barley are generally obtained under irrigation.

Lethent silty clay loam, hummocky, moderate alkali (LE).—A moderate concentration of alkali is the chief difference between this soil and Lethent silty clay loam, hummocky, slight alkali. Generally more alkali, mostly of the white type, is concentrated in the underlying soil than in the coarser textured mounds or hummocks. This soil occurs in small isolated areas and is probably best used as bedding grounds for sheep.

LEVIS SILTY CLAY

Levis silty clay occurs on the nearly level outer parts of alluvial fans and typically contains strong concentrations of alkali consisting almost entirely of neutral salts, or white alkali. The soil is in a basin-rim position and has developed from fine-textured alluvium that originated in calcareous sandstone and shale of the uplands that give rise to the Kettleman series. In many places the surface is slightly

hummocky as a result of heaving, an action that is characteristic of some soils containing much soluble salt. Vegetation consists of alkali-tolerant shrubs and grasses, Atriplex shrubs predominating (pl. 2, *A*). The soil absorbs nearly all the rain that falls, and consequently there is little runoff. The slope is nearly level, being less than 1 percent in gradient.

Levis silty clay, nearly level, strong alkali, is the only separation in this survey.

Profile description.—The surface soil consists of a light brownish-gray or light yellowish-brown silty clay that is intermittently calcareous and averages 10 inches thick. The soil is friable and normally contains a high concentration of alkali that causes a fluffy, or dry-bog, condition in summer when the soil is thoroughly dry.

A grayish-brown or yellowish-brown friable silty clay upper subsoil extends to an average depth of 22 inches, and when dry it has a definite system of vertical cracks that form a weak prismatic structure. Lower in the subsoil, to a depth of 32 inches or more, there is a high salt concentration that tends to flocculate the fine clay particles and to maintain the soil as a soft crumbly mass. The light-brownish gray or light yellowish-brown subsoil extends to depths greater than 60 inches. It is calcareous and gypsiferous and contains moderate quantities of soluble salts. The fine-textured material is friable and porous, but roots and moisture under natural conditions rarely reach the deep subsoil.

Levis silty clay, nearly level, strong alkali (LL).—Several attempts have been made to farm this soil, but its high alkali content will probably never permit profitable cultivation. Reclamation would be impractical, though with large quantities of cheap water, some success with rice would be possible after 1 or 2 years of the leaching and flooding practiced in rice culture. At best, the soil affords a scant sheep pasture of alkali-tolerant weeds and low scattered brush. The carrying capacity is about one sheep to each 4 or 5 acres through the 5-month grazing season.

LOST HILLS FINE SANDY LOAM

Lost Hills fine sandy loam occurs in the western part of the area on very gently sloping to undulating older alluvial fans bordering the foothills. The older alluvium from which the soil has developed originated in the calcareous sedimentary rock materials of the uplands that give rise to the Kettleman soils. Vegetation consists almost entirely of short annual grasses that grow during the rainy season late in winter and early in spring. Surface runoff is negligible to slight, depending largely on the degree of slope.

Based on relief, three separations of Lost Hills fine sandy loam are made—the very gently sloping, gently undulating, and undulating.

Profile description.—To an average depth of 10 inches the surface soil is pale-brown or light yellowish-brown noncalcareous fine sandy loam that is loose, friable, and low in organic matter. This material grades into an upper subsoil of pale-brown friable and calcareous fine sandy loam. There is an abrupt change, at a depth ranging from 22 to 30 inches, to a pale-brown or light brownish-gray moderately compact heavy fine sandy loam or loam of firm consistence and prismatic structure. The cleavage planes of the structural units are generally stained with colloidal matter, and the units contain streaks

of segregated lime. Lower in the subsoil there is a gradual change to a moderately friable light yellowish-brown calcareous fine sandy loam that generally contains a little crystalline gypsum.

Parent material, usually below 50 inches, consists of light brownish-gray or light yellowish-brown calcareous alluvial material. It is stratified, rather coarse textured, and very friable, but under natural conditions roots and water rarely penetrate to these lower depths.

Use and management.—Practically all of Lost Hills fine sandy loam lies above areas supplied with irrigation water, and it is used mainly for sheep pasture. Grazing for a few months in spring is good, but because of the short period suitable for grazing, the carrying capacity on an annual basis is only fair. The soil is suitable for cultivation under irrigation.

Lost Hills fine sandy loam, very gently sloping (Ls).—Slopes are less than 3 percent on this soil. It is not farmed at present, mainly because irrigation water is not available. Under natural conditions the surface has a slight hummocky microrelief that would necessitate more leveling for irrigation than is required on the Panoche soils. Because of the moderately compact subsoil that is characteristic of the Lost Hills soils, there would be some retardation of root and water penetration if this fine sandy loam were cultivated. Consequently, somewhat lower yields of barley, flax, or other crops would be expected than are obtained on the Panoche soils.

The natural vegetation consists of short annual grasses, and the soil is now used mainly as sheep pasture. The carrying capacity is about one sheep each 1½ acres during the grazing season.

Lost Hills fine sandy loam, gently undulating (Lp).—Most of this soil is mapped in relatively small bodies on the old alluvial fans bordering Pleasant Valley. It does not differ significantly in profile characteristics from Kettleman fine sandy loam, very gently sloping. It has a gently undulating (1- to 3-percent gradient) and more hummocky surface than the other Lost Hills fine sandy loam units. If this soil were to be prepared for irrigated farming, more than the usual extent of leveling would be necessary. Leveling costs for the Lost Hills soils are not excessive under ordinary conditions, but where the microrelief is hummocky, the moderately compact subsoil might be exposed in places or left thinly covered by leveling operations. It is doubtful if these areas can be profitably leveled for irrigated farming except under very favorable conditions of abundant and cheap water supply.

The best use at the present time is for sheep pasture and bedding grounds. The carrying capacity is similar to that for the very gently sloping areas of Lost Hills fine sandy loam.

Lost Hills fine sandy loam, undulating (Lr).—These areas are located on short relatively steep old fans. They have an unusually pronounced and undulating hummocky relief, with dominant slopes of 3 to 7 percent. Under present conditions the surface is too uneven to be leveled for irrigated farming, and even if an adequate water supply were available, great care would be required in irrigation.

The soil is best used for sheep pasture and sheep bedding grounds. A fairly good stand of annual grasses supplies forage until late spring. From 1½ to 2 acres are needed to graze one sheep through the season.

LOST HILLS CLAY LOAM

Lost Hills clay loam occurs on very gently sloping to undulating older alluvial fans bordering the foothills in the western part of the area. Parent material consists of alluvium that originated where areas of calcareous sedimentary rocks of the uplands give rise to the Kettleman soils. The vegetation consists of short annual grasses that begin growth in winter and continue until the rainy season ends in April or May. On most areas surface runoff is negligible, although it may be slight on undulating areas.

Three separations have been made on the soil map. These are based on slope and relief that would affect the management of the soil under irrigation. The separations are the very gently sloping, gently undulating, and undulating.

Profile description.—The surface soil, about 10 inches deep, is grayish-brown or pale-brown noncalcareous clay loam that is moderately friable and penetrable to roots and water. The soil is slightly hard and breaks to a poorly defined blocky structure when dry, but depending on the moisture content, it becomes sticky or plastic when wet.

The surface soil grades into an upper subsoil of yellowish-brown or pale-brown intermittently calcareous clay loam that is slightly compact and slightly less permeable to roots and water. There is an abrupt transition at an average depth of about 20 inches to a brown or pale-brown calcareous compact clay or heavy clay loam that is 15 or 20 inches thick and has a well-defined prismatic structure. The cleavage planes of the structural units in this clay are visibly stained with a dark coating of colloidal material, and the whole mass is impregnated with small specks and seams of segregated lime. Root and water penetration are definitely retarded by this horizon. The lower subsoil normally is friable and consists of light yellowish-brown calcareous loam or light clay loam that generally contains some crystalline gypsum. Under natural conditions, roots and water seldom penetrate into the lower subsoil.

Below a depth of 40 or 50 inches there is alluvial parent material consisting of a light brownish-gray or light yellowish-brown calcareous loam or clay loam that is commonly stratified with highly calcareous and sometimes gypsiferous sediments. This parent material is friable and extends to considerable depth.

Use and management.—Almost all of the Lost Hills clay loam is used for sheep pasture, mainly because a supply of irrigation water has not been developed. Sheep grazing for a short period in spring is fairly good, but otherwise carrying capacity for livestock is low. The soil is suitable for cultivation under irrigation.

Lost Hills clay loam, very gently sloping (Lo).—Most of this soil occupies very gentle slopes of less than 3 percent. It is mapped along the base of foothills, mainly in Pleasant Valley. Outside of Pleasant Valley and about 7 miles southwest of Delta Farms are a few spots having slight accumulations of salts in the subsoil. At present none of the soil is cultivated, because irrigation water is not available. If the soil is sometime irrigated, it will be best suited to shallow-rooted crops, as barley and flax, because of its compact subsoil. Although the general surface is only very gently sloping, it is somewhat hummocky and would need considerable leveling before irrigation could be carried on efficiently.

The natural vegetation consists of short annual grasses. The principal use at present is for sheep pasture; the carrying capacity is about 1½ acres per sheep for the grazing season.

Lost Hills clay loam, gently undulating (LM).—These areas have an uneven surface of 1- to 3-percent slope and will need much leveling before they can be irrigated. A more pronounced hummocky surface is the main distinction between this soil and very gently sloping areas of Lost Hills clay loam. Leveling costs would not be excessive, but leveling would in places expose some of the compact subsoil material or leave it only thinly covered. It is doubtful that this soil should be leveled for irrigation unless a larger supply of cheaper irrigation water becomes available.

In the Mendota area,[13] several areas of Lost Hills soil similar to this soil but with a somewhat smoother surface have been leveled and successfully farmed to irrigated barley, flax, and grain sorghum. In this area, however, sheep pasture will be the best use for the soil until a larger supply of irrigation water is assured. In grazing value this soil is similar to the very gently sloping areas of Lost Hills clay loam.

Lost Hills clay loam, undulating (LN).—This soil is located on short relatively steep old alluvial fans at the base of foothills. It has a hummocky microrelief and an undulating relief with slopes 3 to 7 percent in gradient. The surface relief is too uneven to be smoothed or leveled economically for irrigated farming under present conditions. An area of about 3 miles south of Oilfields has a more gently sloping than undulating relief.

Most of the soil is used for pasture and bedding grounds for sheep. The fairly good stand of annual range grasses is pastured until late spring. The carrying capacity is one sheep each 1½ or 2 acres for the grazing period.

LOST HILLS LOAM

Lost Hills loam occurs on very gently sloping to gently sloping older alluvial fans bordering the foothills. It is associated with other soils of the Lost Hills series in the western part of the area. The parent material consists of alluvium that comes from the calcareous sedimentary rock materials of the uplands upon which soils of the Kettleman series have developed. The vegetation consists almost entirely of short annual grasses that flourish for a few months late in winter and early in spring. Surface runoff is negligible to slight, depending largely on the degree of slope.

Because of the effect slope would have on this soil if it were irrigated, two separations based on slope have been made on the soil map—the very gently sloping and the gently sloping.

Profile description.—The surface soil is pale-brown or light yellowish-brown noncalcareous loam that is friable and easily penetrated by roots, air, and water. It normally is about 10 inches deep. The upper subsoil is about 11 inches thick, intermittently calcareous, pale brown or light yellowish brown, and moderately friable. At a depth of 20 to 28 inches there is an abrupt change to a brown or pale-brown moderately compact clay loam of well-defined prismatic structure. The structural units are noticeably glazed with colloidal material and

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[13] See footnote 1, p. 3.

permeated with fine seams of segregated lime. Root and water penetration are retarded significantly by the compactness of this horizon, which is normally about 18 inches thick.

The lower subsoil consists of a friable light yellowish-brown calcareous loam that generally contains an appreciable quantity of crystalline gypsum. Roots and water rarely penetrate this deep subsoil under natural conditions. Below a depth of 50 or 60 inches is the substratum, usually a light brownish-gray or light yellowish-brown calcareous fine sandy loam that is generally stratified with coarser and finer textured alluvial materials.

Use and management.—Lost Hills loam is not farmed in this area because irrigation water is not available. The hummocky surface would necessitate considerable leveling before irrigation could be done efficiently. If the soil were cultivated under irrigation, shallow-rooting crops would be more successful than others because of the compact subsoil. A fairly good stand of annual range grasses develops in spring and provides pasture for sheep until late in spring.

Lost Hills loam, very gently sloping (Lu).—This soil occurs on slopes of less than 3 percent at the base of foothills. None of it is farmed at present, because a supply of irrigation water has not been developed. If leveled, the soil is suitable for cultivation under irrigation, but because of the somewhat hummocky microrelief, more leveling would be required than for the smoother Panoche soils. About 4 miles northeast of Oilfields a few small areas have a more pronounced hummocky microrelief than typical and would be more difficult to level for irrigation. The grazing capacity for sheep is similar to that for other very gently sloping soils of the Lost Hills series.

Lost Hills loam, gently sloping (Lt).—In respects other than slope, this soil is similar to very gently sloping Lost Hills loam. Slopes range from 3 to 7 percent. The soil probably will not be brought under irrigation and cultivated until a cheaper more abundant water supply is developed. A fairly good stand of range grasses develops in the rainy season and supplies forage for sheep until late in spring. The grazing value is similar to that for other Lost Hills soils of corresponding slope.

MERCED CLAY (ADOBE)

Merced clay (adobe) lies in basin positions. It is imperfectly drained and under natural conditions was periodically flooded by overflow water coming chiefly from Fresno Slough. The parent material is alluvium, mainly of granitic rock origin, that was deposited by slowly moving floodwaters. The natural vegetation was mostly water-loving grasses, willows, and, in some places, tules. Most of this soil is now under cultivation and protected from overflow by levees. Surface runoff is very slow, and the soil is affected by a high water table, particularly during the rainy season.

Three separations of this nearly level type are shown on the map. These are based on whether or not the soil is free of alkali and whether it contains slight or moderately strong accumulations of alkali.

Profile description.—To an average depth of 10 inches the surface soil consists of dark-gray noncalcareous clay that is nearly black when moist. When the soil dries it cracks into large blocks often 12 inches

across; when wet, it runs together and becomes sticky. This material is usually slightly gritty and micaceous and has a neutral or slightly basic reaction.

The upper subsoil averages about 14 inches thick and is dark-gray, mottled, and intermittently calcareous clay that is moderately compact and of coarse blocky structure. Lower in the subsoil, to depths of less than 40 inches, is a dark grayish-brown or dark olive-gray, mottled, moderately compact clay with well-developed coarse prismatic structure. A concentration of segregated lime occurs in this horizon in the form of small specks and soft concretions. The surfaces of the structural aggregates are stained with mineral and colloidal material. Root and water penetration are definitely retarded. The deep subsoil is grayish-brown or olive-gray moderately calcareous slightly micaceous clay or clay loam that is mottled from the recurrent high water table. The soil in place is massive, but it breaks into small irregularly shaped blocks.

The underlying substratum occurs below an average depth of about 60 inches and is composed of plastic sandy clay loam alluvium that is pale brown to olive gray depending upon the ground water conditions that have prevailed. This soil material is micaceous, contains calcareous nodules, and is mottled from the high water table that is characteristic of most of the basin soils.

Use and management.—Because of its heavy texture, the soil is difficult to work and to prepare for seeding. Fair to good yields are obtained from shallow-rooted field crops such as barley, cotton, and grain sorghums. Because of the heavy texture and imperfect drainage, the soil is not well suited to deep-rooted crops. The land should be occasionally fallowed and fertilized with a complete fertilizer for the best yields of field crops.

Merced clay (adobe), nearly level (MA).—This alkali-free soil occurs in a large area in the northeastern part of the survey. It is similar to the other units of the type, although typical Merced clay (adobe) soils have slight accumulations of alkali. Cultivation and crop production are affected by the heavy texture of the surface soil, very slow surface drainage, and high water table. Most of the soil is cultivated, and protected from overflow by levees. Good yields of barley and fair yields of cotton and grain sorghum are obtained under irrigation. Deep-rooted orchard crops and alfalfa are not well suited.

Merced clay (adobe), nearly level, slight alkali (MC).—Slight concentrations of alkali are generally distributed evenly throughout this soil. In places, however, the salts may be concentrated in the subsoil, with only a very small quantity in the surface soil. The salts are of the white-alkali type and not so toxic as comparable black-alkali concentrations. Areas of this soil are located in the northeastern corner of the area near or along Fresno Slough.

The soil is fairly difficult to work and to prepare for seeding because of its heavy texture. Fair yields of barley, cotton, and grain sorghum are obtained where the areas are protected from overflow and where the ground water does not remain high for long periods. Permanent pasture is generally established on frequently flooded lands or those with a consistently high water table. Summer fallowing, crop rotation, and an occasional complete fertilization have been the most suc-

cessful management practices in maintaining maximum yields. Irrigation water is supplied through canals from Fresno Slough; it is of good quality but distributes seeds from undesirable weeds.

Merced clay (adobe), nearly level, moderately strong alkali (MB).—A large area of this soil occurs in the northeastern part of the survey. It has slight to moderate concentrations of alkali in the surface soil and strong concentrations in the subsoil. The alkali is dominantly the white type, but the more toxic black alkali is present in some places.

Agricultural use is definitely limited, for in addition to a serious alkali condition, the soil is heavy textured, difficult to manage, and affected by a high water table. Permanent irrigated pasture of alkali-tolerant grasses is probably its more efficient use. If sufficient water were available, rice probably could be grown fairly successfully.

MERCED CLAY LOAM

Merced clay loam has many characteristics similar to Merced clay (adobe) and differs primarily in having a lighter textured surface soil and somewhat lighter textured subsoil and substratum.

Only one separation—the spotted alkali unit—of this nearly level type has been made in this survey.

Profile description.—The surface soil, averaging 12 inches deep, consists of a friable noncalcareous clay loam that is dark gray and well supplied with organic matter. It grades into an upper subsoil about 16 inches thick that consists of mottled dark-gray intermittently calcareous clay loam containing a moderate quantity of organic matter. The material in this layer is slightly compact and not so friable as the surface soil.

Lower in the subsoil, to an average depth of 40 inches, the material is a mottled dark grayish-brown moderately compact clay with a well-developed prismatic structure. There is usually a concentration of segregated lime in this horizon, and the structural units are stained with mineral and colloidal material. Root and water penetration are definitely retarded. The underlying deep subsoil, or substratum, occurs at a depth of about 5 feet. It is variable in texture and color, grading from grayish-brown clay loam to olive-gray plastic sandy clay loam. This material is usually highly calcareous and micaceous and strongly mottled by a fluctuating water table.

Merced clay loam, nearly level, spotted alkali (MD).—This soil is confined to one relatively small body in the northeastern part of the area near the Fresno-Kings County line. A few spots of alkali accumulation slightly reduce its productivity. Yields of barley, cotton, and grain sorghum are normally fair to good when the management practices commonly used for these crops are followed. Irrigation water is obtained from Fresno Slough.

MERCED SILTY CLAY LOAM, SHALLOW OVER LETHENT SILTY CLAY

This soil is essentially a shallow deposit of Merced silty clay loam over Lethent silty clay. It is an overwash soil and generally occurs in a transition zone between areas of typical Lethent and Merced soils.

Two separations based on differences in alkali content have been made on the map—the spotted alkali and the moderately strong alkali.

Profile description.—In most places the surface soil, to a depth of 8 to 20 inches, is a dark grayish-brown intermittently calcareous silty clay loam fairly typical of the surface soil of the Merced series. The underlying Lethent soil material is characteristically a yellowish-brown compact silty clay that generally contains an appreciable quantity of segregated lime and gypsum. Some alkali normally occurs in this lower material, and in a few places there are slight and moderate concentrations in the surface soil.

Merced silty clay loam, shallow over Lethent silty clay, nearly level, spotted alkali (MF).—Several areas of this soil are in the northeastern part of the survey. Fair yields of cotton and grain sorghum and good yields of barley are normally obtained under irrigation. Yields are somewhat lower where the Merced silty clay loam material is shallower, and apparently differences in depth of the Merced material affect yields to a greater degree than the spotted alkali condition. Seeded and irrigated pasture is well suited.

Merced silty clay loam, shallow over Lethent silty clay, nearly level, moderately strong alkali (ME).—This soil consists of a relatively shallow deposit of Merced silty clay loam over Lethent silty clay and contains moderately strong concentrations of alkali. Occasionally a planting of barley, cotton, or grain sorghum is attempted, but yields are generally poor. The soil is probably best used for permanent irrigated pasture of wild and domestic alkali-tolerant grasses.

OIL-WASTE LAND

A few scattered areas adjacent to oil wells are saturated with oil waste where the sludge from drilling was allowed to spill out. This Oil-waste land (OA) is useless for agriculture but essential in drilling and pumping oil wells.

ORTIGALITA CLAY LOAM

Ortigalita clay loam occurs on gently undulating older alluvial fan materials near Los Gatos Creek northwest of Coalinga. The microrelief is hummocky. The soil is moderately well developed and occurs on alluvium that originated for the most part in relatively hard and, in places, somewhat metamorphosed sandstone and shale of the higher Coast Range to the west. Vegetation consists of annual grasses and some bur-clover and alfileria. Surface runoff is adequate, and the soil is not affected by a high water table.

Only one separation of Ortigalita clay loam—the gently undulating unit—is mapped.

Profile description.—The brown noncalcareous clay loam surface soil is permeable to roots and water and extends to an average depth of about 15 inches. When dry, it is brittle; when wet, there is some tendency for it to run together and become plastic.

The upper subsoil is 8 inches or less thick and consists of a light yellowish-brown intermittently calcareous clay loam that is slightly compact and of indefinite structure. There is a rather abrupt change to a moderately compact lower clay loam subsoil of distinct prismatic

structure. This lower subsoil contains segregated lime, ranges from 12 to 16 inches thick, and in many places contains a considerable quantity of small rounded gravel. Root and water penetration are definitely retarded by the compactness. Lower in the subsoil, to depths generally less than 50 inches, the soil is light yellowish brown, moderately calcareous, and medium textured. Definite structural units are lacking, and the soil is less compact and more friable than the soil material above. An appreciable quantity of well-rounded, medium-sized, lime-coated gravel is generally present, the amount depending on the character of the underlying material. The underlying material consists of gravelly alluvium related to the Ortigalita soils, or of remnants of older unrelated gravelly terrace materials.

Ortigalita clay loam, gently undulating (OB).—The distinct hummocky microrelief of this soil would require much leveling for irrigation. None is cultivated at present, because it lies above existing areas of water supply. It is fairly well suited to irrigated agriculture and would have a use similar to that of Lost Hills clay loam, gently undulating. Slopes range from 2 to 7 percent. Surface drainage is not excessive, and there has been no appreciable erosion or deposition during recent years. Short annual grasses and some bur-clover and alfileria flourish in spring and afford fairly good pasture for sheep during this period. The carrying capacity is about one sheep for each 1½ or 2 acres for the grazing season.

OXALIS SILTY CLAY

Oxalis silty clay occurs in a basin-rim position on nearly level outer parts of broad alluvial fans. It normally contains some alkali concentration. The parent material is fine-textured alluvium that originated in the calcareous sandstone and shale of the uplands that give rise to the Kettleman series. Surface runoff is very slow, but the soil is not affected by a high water table. The vegetation consists of short annual grasses, the more alkali-tolerant grasses and herbs becoming increasingly prominent where moderate alkali concentrations occur.

Two separations of this type, based on slight and moderate alkali content, are made on the map.

Profile description.—The grayish-brown to pale-brown silty clay surface soil ranges from 12 to 20 inches deep. It is heavy textured and easily puddled if worked too wet. On drying after an irrigation, the silty clay cracks and checks deeply, producing blocks 8 to 12 inches square and forming an adobelike structure. These blocks in turn develop a system of secondary cracks on further drying. Moderate quantities of disseminated lime are normally present in the surface soil, but in areas transitional to the Lethent soils, the lime content may be rather low.

The upper subsoil is grayish brown or yellowish brown, fine textured, and fairly high in concentration of lime and gypsum. Lower in the subsoil, at depths ranging from 30 to 44 inches, the material usually contains a considerable quantity of free lime and crystalline gypsum. Some stratification of coarse material may be present near areas of buried stream channels. In these areas the deep subsoil is often pale brown, mildly calcareous, and friable. Irrigation water penetrates to the lower subsoil, but roots of shallow-rooted crops and

of grass vegetation rarely penetrate this far in the profile. Alkali accumulations normally occur in the soil and are generally more concentrated in the subsoil than in the surface soil.

Use and management.—Most of the Oxalis silty clay in this area is cultivated to barley, cotton, flax, and grain sorghum. Differences in yield on this soil are due primarily to differences in alkali content.

Oxalis silty clay, nearly level, slight alkali (OD).—The slight accumulation of alkali in this soil occurs chiefly in the subsoil, and the salts are almost entirely of the neutral, or white-alkali, type. Because of the relatively high salt content in the water pumped for irrigation, it is doubtful that the salt content of the soil can be lowered significantly. Care is necessary, however, to prevent further accumulation of salt and to prohibit rising of salt from the subsoil to the surface soil.

Satisfactory yields of barley, cotton, flax, and grain sorghum are obtained under irrigation. Consistently good yields can be maintained if a system of fallowing and crop rotation is used with an occasional green-manure crop or an application of nitrogen fertilizer. Although the surface is smooth and nearly level, surface drainage for irrigation is adequate.

Oxalis silty clay, nearly level, moderate alkali (Oc).—Most of this soil occurs in small- or medium-sized bodies in the northeastern part of the area. It lies adjacent to other soils containing salts and occurs in basin-rim positions. As in areas slightly affected by alkali, the salts of this soil are of the neutral, or white-alkali type, but concentrations are higher. In most places the salts are concentrated in the subsoil, but slight quantities usually are present in the surface soil.

Reclamation is of doubtful feasibility under the present limited supply and quality of irrigation water. If a greater supply of irrigation water were available, rice could be grown successfully, and seeded and irrigated pasture would be profitable. The fair yields of barley and cotton obtained can be maintained only if the salts are held in the subsoil below the rooting zone. Barley and cotton yields are definitely lower than where Oxalis soil is only slightly affected by alkali.

PANHILL FINE SANDY LOAM

Panhill fine sandy loam occurs on very gently sloping to gently undulating alluvial fans located fairly close to the hills. The surface microrelief is slightly to moderately hummocky. The alluvial material making up the fans originated mostly in the calcareous sandstone and shale of the uplands from which Kettleman soils have developed. The vegetation is short annual grasses that grow during the rainy season late in winter and early in spring. Surface runoff is negligible, and internal drainage is adequate to keep the soil well drained.

Two separations of Panhill fine sandy loam based mainly on slope and microrelief have been made in this area—the very gently sloping and the gently undulating.

Profile description.—To an average depth of 16 or 20 inches the surface soil is noncalcareous, friable, and light yellowish brown. It is usually underlain by a pale-brown or yellowish-brown calcareous

loam upper subsoil that is slightly compact and of indistinct prismatic structure. The lime in the upper subsoil is partly segregated and concentrated into a zone about 12 inches thick. Moisture and roots can easily penetrate the subsoil, but they rarely do so because rainfall is low and the short grass vegetation is shallow rooting. At depths below 40 inches there is a gradation to light brownish-gray or light yellowish-brown moderately calcareous loam or sandy loam that is generally stratified with thin layers of highly calcareous silty sediments. This lower material is friable and structureless.

Use and management.—Most of this soil is not cultivated because it lies above irrigation ditches, but in a few places, particularly in Pleasant Valley, it is farmed. The soil is well suited to barley, cotton, and grain sorghum under irrigation. Where cultivated to these crops, occasional fallowing along with occasional applications of a nitrogen fertilizer have proved important in maintaining good yields.

Panhill fine sandy loam, very gently sloping (PD).—Slopes are less than 3 percent on this soil, and the slight hummocky microrelief is easily leveled for irrigation. Very good yields of barley, cotton, and grain sorghum are obtained in Pleasant Valley. Most of the soil, however, is not cultivated and is used for sheep grazing. The carrying capacity is about 1½ or 2 acres per sheep for the grazing season. The soil is not eroded at present, but it tends to gully easily if irrigation ditches are long and have an average gradient of more than 2 percent.

Panhill fine sandy loam, gently undulating (PC).—The uneven surface of this soil requires more than the usual amount of leveling before the land can be irrigated. Since the soil is deep and friable, leveling can be performed easily without disturbing its inherently good physical qualities (pl. 3, *A*). Little of the soil has been leveled for irrigation in this area, but if water were available, good yields of barley, flax, grain sorghum, and other crops adapted climatically to the region could be grown. Slopes are mainly 1 to 3 percent in gradient, although in a few places they are slightly above 3 percent. Irrigation water should be handled carefully, for the soil gullies easily. Short irrigation ditches on low gradients minimize the danger of gullying. Most of the soil is used for sheep pasture; its carrying capacity is similar to that of very gently sloping Panhill fine sandy loam.

PANHILL LOAM

Panhill loam has many characteristics similar to Panhill fine sandy loam. The principal difference is the slightly heavier texture of its surface soil. The soil occurs on very gently sloping to gently undulating alluvial fans in association with other soils of the Panhill series and with Panoche soils. Parent material, natural vegetation, and general position are similar to those of Panhill fine sandy loam.

Three separations of Panhill loam have been made in this area. They are the very gently sloping; very gently sloping, slight alkali; and gently undulating units.

Profile description.—The surface soil has an average depth of about 16 inches and consists of light yellowish-brown noncalcareous or very slightly calcareous loam that is friable and easily penetrated by roots and water. There is a distinct change to a calcareous upper subsoil

of yellowish-brown or pale-brown slightly compact loam of weakly developed prismatic structure. This upper subsoil is about 14 inches thick and is a zone of some segregated lime accumulation. Root and water penetration are only slightly retarded. The lower subsoil, below 45 inches, is usually a light brownish-gray or light yellowish-brown moderately calcareous loam or clay loam that is friable and generally stratified with thin layers of highly calcareous silty sediments. Moisture from rainfall is rarely sufficient to penetrate into the deep subsoil.

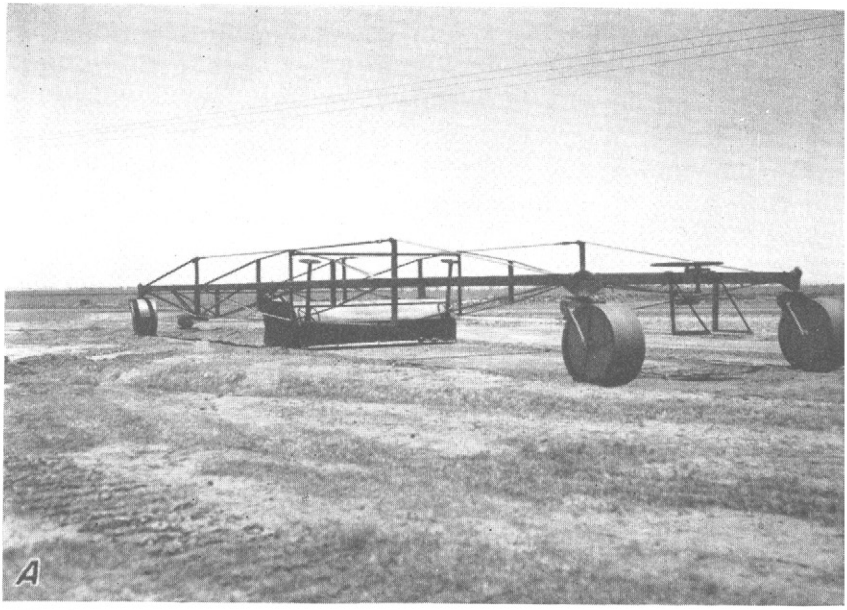
Use and management.—A few small bodies are farmed under irrigation, but in most places the soil is situated along the base of the foothills above the irrigated sections. In general, the soil is well suited to intensive agriculture under irrigation.

Panhill loam, very gently sloping (PF).—This soil occupies slopes of less than 3 percent. Its slightly hummocky microrelief is easily leveled, and the surface soil is easily prepared for planting. It tends to gully easily under irrigation, and irrigation ditches should be checked frequently and confined to a gradient of less than 2 percent. Laterals and row ditches should parallel the general contour of the land as closely as possible. The soil should be fallowed every few years and occasionally treated with a nitrogen fertilizer in order to maintain yields. Barley, grain sorghum, and other crops adapted to the region are well suited. Where not cultivated, fairly good stands of short annual range grasses afford pasture for sheep until late in spring. Each sheep needs about 1½ acres for the grazing season.

Panhill loam, very gently sloping, slight alkali (PG).—In general, salts are evenly distributed throughout the soil profile, but in this and other areas designated as being affected with slight alkali, the soil does not necessarily have the same quantity of salt in all parts. Some very small areas may actually be free of alkali, and others may have moderate concentrations in the subsoil and be free of alkali in the surface 12 inches.

With proper management and with irrigation water of good quality, good yields of barley and cotton can be obtained on this soil, and under careful irrigation the alkali concentration could actually be lowered. As with other soils of the area, crop rotation, occasional fallowing, and nitrogen fertilization should be followed in order to maintain good yields. The grazing value for sheep is essentially the same as for areas of Panhill loam that are free of alkali.

Panhill loam, gently undulating (PE).—Profile characteristics of this soil do not differ significantly from those of the very gently sloping Panhill loam. The soil has been separated chiefly because it has a gently undulating and uneven surface that would require more than the usual amount of leveling before it could be farmed under irrigation. Leveling operations could be performed easily and with good results because the soil is deep and friable. It is doubtful, however, that any areas will be leveled and irrigated with the present water supply. They are too far elevated above the normal pumping levels of the valley. Slopes range dominantly from 1 to 3 percent, but in a few places are slightly more. Short annual grasses provide sheep pasture for several months late in winter and in spring. The value for grazing is similar to that for the very gently sloping Panhill loam.



A, Landplane, a type of heavy equipment used to level land for irrigation in extensive farming operations in this area.
B, Turbine-type pumping plant powered by 125-horsepower electric motor. This well is 1,900 feet deep; water is lifted 300 feet and delivered at a rate of about 1,400 gallons a minute.

PANHILL SANDY LOAM

Panhill sandy loam is the coarsest textured type of the Panhill series mapped in the area. It occurs on very gently sloping to gently undulating alluvial fans in association with soils of the Panoche series and with other soils of the Panhill series. In many respects it is similar to Panhill fine sandy loam, differing principally in the coarser texture of the surface soil and somewhat more stratified subsoil.

Because of differences in slope and surface unevenness, two separations of Panhill sandy loam have been made in this area—the very gently sloping and gently undulating units.

Profile description.—The surface soil is about 20 inches deep and light yellowish brown, noncalcareous, and loose. There is a gradual and irregular transition to a calcareous upper subsoil consisting of a pale-brown or yellowish-brown light loam or sandy loam that is friable and easily penetrated by roots and water. The lime in the upper subsoil is generally segregated and concentrated in a definite zone about 14 inches thick.

Lower in the profile, below an average depth of about 40 inches, the soil is light yellowish brown, moderately calcareous, friable, coarse textured, loose, and permeable. Under natural conditions, moisture from the low rainfall of the region seldom reaches the lower subsoil. This material lacks definite structure, is generally somewhat stratified, and extends to an undetermined depth. In a few places occur thin stratifications of silty sediments that are highly calcareous. Except for the partly leached surface soil and the definite zone of lime accumulation in the upper subsoil, the soil is much the same as Panoche sandy loam.

Use and management.—Only a small acreage of Panhill sandy loam is cultivated, mainly because most of it is outside of the irrigated areas and higher up on the alluvial fans. The surface is generally slightly hummocky, and somewhat more leveling is required in preparing the land for irrigation than for the Panoche soils. If irrigation water were available, the soil would be well suited to the production of a wide range of crops climatically adapted to the area.

Panhill sandy loam, very gently sloping (Pi).—Most areas of this soil occur in small bodies along the base of the foothills. Slopes are less than 3 and mostly less than 2 percent. Although the surface is slightly hummocky, it would be little trouble to level it for irrigation. Little of the soil is now cultivated; most of it is used for pasturing sheep. The carrying capacity is about one sheep for 2 acres through the 5-month grazing season. The soil is not particularly erodible under natural conditions, but under irrigation it would gully easily if water were not properly managed. It is well suited to most crops commonly grown in the area.

Panhill sandy loam, gently undulating (Ph).—This soil occurs mainly along the eastern slopes of Anticline Ridge. It is essentially the same as very gently sloping Panhill sandy loam except for its more uneven and hummocky surface. None of it is now cultivated, and preparation for irrigated farming would require more than the usual amount of leveling. Nevertheless, it is a deep friable soil that could be easily leveled without damaging it excessively. Water requirements are somewhat higher than for other Panhill soils, but if

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irrigation water were available the soil could be profitably farmed to barley, flax, grain sorghum, and other crops. In value for sheep grazing, this soil is about the same as the very gently sloping areas of Panhill sandy loam.

PANHILL CLAY LOAM

Panhill clay loam is the heaviest textured type of the Panhill series mapped in the Coalinga area. Like other Panhill soils, it occurs on very gently sloping or gently undulating alluvial fans near the base of the foothills and is associated with the Panoche soils and with other Panhill types. The parent material consists of alluvium originating in the calcareous sandstone and shale hills occupied by Kettleman soils. The vegetation consists of the annual grasses common on most soils of the area.

Two units of Panhill clay loam shown on the soil map are the very gently sloping and the gently undulating

Profile description.—The surface soil is light brownish-gray or light yellowish-brown noncalcareous or very slightly calcareous clay loam. This layer, 16 or 20 inches thick, is friable and easily penetrated by roots and water. It breaks into soft nutlike aggregates if disturbed when dry. The wet soil is slightly browner than the dry soil and, depending on the degree of wetness, tends to become plastic or sticky.

A grayish-brown or yellowish-brown upper subsoil is distinguished from the surface soil by the presence of disseminated lime and some vertical cracking. Well-preserved root holes and insect borings penetrate this layer and aid moisture and root penetration. At a lower depth not exceeding 30 inches, the subsoil is pale brown or light yellowish brown and contains a definite zone of segregated lime ranging from 8 to 12 inches thick. The compaction of this layer only slightly retards root and moisture penetration. Lower in the profile, to depths of 40 inches and more, the material is similar to that in the subsoil of Panoche clay loam. Frequently this material is stratified with thin highly calcareous silty layers that may contain small quantities of crystalline gypsum. The color varies from pale brown to light yellowish brown, and the material is uniformly calcareous and friable.

Use and management.—Because it is on the higher parts of alluvial fans above the irrigated sections, only a small acreage of this soil is cultivated. Most of it is used for sheep pasture.

Panhill clay loam, very gently sloping (PB).—This soil occurs on slopes of less than 3 percent and has a slightly hummocky surface that could be easily leveled for irrigation. It does not erode under the arid climate of the region, but irrigation ditches with an average gradient of more than 2 percent would tend to gully. Only a small acreage is cultivated because the soil is situated on the higher parts of alluvial fans above the irrigated sections. However, the soil is well suited to irrigated agriculture, particularly to barley, cotton, and grain-sorghum crops. At present most areas are used for sheep pasture; about 1½ acres are needed to carry one sheep through the grazing season.

Panhill clay loam, gently undulating (PA).—The uneven surface of this soil would require more than the usual amount of leveling

before it could be farmed under irrigation. No particular difficulty would be experienced after leveling, because the soil is deep and friable. None of this soil, however, has been prepared for irrigation in this area. It lies near the foothills at elevations presumably too high for pumping irrigation water. Relief ranges from 1 to 3 percent; a few small areas have slopes slightly above 3 percent. The value for grazing is similar to that of very gently sloping Panhill clay loam.

PANOCHE CLAY LOAM

Panoche clay loam occurs predominantly on very gently sloping smooth recent alluvial fans, although a few areas have a gently undulating relief. The parent material consists of recently deposited alluvium that originated in the calcareous sandstone and shale of the uplands on which the Kettleman soils occur. The vegetation consists of the characteristic short annual grasses that grow during the late winter and early spring. Surface runoff is negligible, for the soil absorbs most of the rain that falls. Slope is sufficient, however, to drain the soil adequately under irrigation, and there is no high water table.

Panoche clay loam is mapped in four units—very gently sloping; very gently sloping, slight alkali; very gently sloping, moderate alkali; and gently undulating.

Profile description.—The soil shows very slight or no profile development, and layers within the profile are caused by stratification. The surface soil is calcareous. It is usually light brownish gray but may be light yellowish brown in places. The range in depth is from 10 to 36 inches, with an average depth of 22 inches. The material is friable and crumbly and can be worked easily to a good seedbed when at the proper moisture content. The organic-matter content of the surface soil is inherently low, but in this zone the roots of shallow-rooted plants are concentrated and a fair nitrogen level can be maintained with proper management.

There is a gradual transition into a subsoil that is deep, pale brown or yellowish brown, and easily penetrated by roots and water. Some segregated lime and crystalline gypsum may be present in the deep subsoil, and generally there is some degree of stratification of medium- and coarse-textured alluvium.

The soil usually occurs as a transitional zone between Panoche loam and Panoche silty clay, and to some extent it consists of a mixture of medium- and fine-textured alluvial material.

Use and management.—Where irrigation water is available, most of the soil is intensively farmed to barley, flax, and cotton, and good to excellent yields are obtained. Truck crops, such as carrots, cabbage, onions, and potatoes, are also successfully grown. The soil is not uniformly productive, however, because of concentration of alkali in a few places and because of minor differences in relief.

Panoche clay loam, very gently sloping (Pk).—This soil has a very gently sloping smooth relief of less than 3 percent and mainly of 1 percent. It occurs in large bodies on the broad recent alluvial fans of the main valley. No appreciable erosion has taken place, and in some areas near stream channels there is an occasional deposit of medium-textured alluvium. This soil is susceptible to gullying under

irrigation, however, and improper irrigation can cause serious gullying to develop rapidly.

Under irrigation the soil is well suited to a number of crops climatically adapted to the area. Among these are barley, flax, cotton, grain sorghum, and truck crops such as carrots, cabbage, onions, and potatoes. Yields are good to excellent; the better yields are obtained where the soil is summer fallowed or green manured every few years and a nitrogen fertilizer is occasionally applied. Uncultivated areas produce a relatively good stand of short annual grasses and some bur-clover and alfileria that afford pasture for sheep until summer. The carrying capacity is about one sheep each 1½ acres for the grazing season.

Panoche clay loam, very gently sloping, slight alkali (PM).—The slight accumulation of soluble salts in this soil distinguishes it from the very gently sloping unit having no alkali. The salts are fairly evenly distributed throughout the soil profile and cause some reduction in general crop yields. There is some variation in the concentration of alkali over an area, however, and it may be absent in a few places.

In general, the soil is farmed and managed the same as Panoche clay loam that is free of alkali. Crops less affected by alkali are barley and cotton; but flax, grain sorghum, and a few selected vegetables are profitably grown. A large part of the soil that is farmed is irrigated from deep wells, and it is especially important that water used for irrigation be of good quality so that additional salts will not be added to the slight concentration already present. The grazing value for sheep is about the same as for areas of Panoche clay loam free of alkali.

Panoche clay loam, very gently sloping, moderate alkali (PL).—Because this soil contains moderate concentrations of soluble salts, it is of less value than the other Panoche clay loam units for agricultural use. The salts are of the white-akali type and generally are concentrated in the subsoil, but normally there is a sufficient quantity in the surface soil to cause an appreciable reduction in yields of even shallow-rooted crops.

Panoche clay loam, gently undulating (PJ).—This soil occupies areas along the foothills that have 1 to 3 percent slopes. An uneven or hummocky surface that requires more than the usual amount of leveling to prepare it for irrigated farming is the chief difference between this soil and very gently sloping areas of Panoche clay loam. Leveling operations, however, are relatively simple and inexpensive and would not disturb greatly the natural productivity of the soil. Wherever water is available, the soil has been profitably leveled for irrigated crops. The application of irrigation water by open ditches should be made with care, for the soil tends to gully easily where ditches are long and of more than 2-percent gradient. The grazing value for sheep is about the same as for very gently sloping Panoche clay loam.

PANOCHE LOAM

Panoche loam occurs on broad recent alluvial fans. The predominant slope is very gentle, although a few areas have a gently

undulating relief. Position, parent material, and vegetation are very similar to those for Panoche clay loam.

Because of differences in alkali content and in slope, the very gently sloping; very gently sloping, spotted alkali; and gently undulating units are mapped.

Profile description.—The 20-inch surface soil consists of a light brownish-gray or light yellowish-brown calcareous loam that is porous and friable. Under natural conditions there is some variation in the texture of the surface soil within short distances, but in cultivated areas the material has been so mixed together that the average texture is a loam.

The subsoil, to depths in excess of 72 inches, is uniformly friable and calcareous but generally stratified with fine and coarse-textured alluvium. The fine-textured strata are somewhat darker than the coarse-textured strata and are commonly very silty. Internal drainage varies with the kind and degree of stratification, but in only a few small areas is drainage either excessive or seriously retarded. Roots may easily penetrate into the deep subsoil.

Panoche loam, very gently sloping (Pr).—Areas of this soil are widely distributed on recent alluvial fans in the main valley. They occupy very gently sloping smooth slopes that are less than 3 percent and average about 1 percent in gradient. Deposition of medium-textured material by floodwaters rather than erosion is normal under natural conditions, but if improperly irrigated the soil gullies easily. A few small areas contain a very slight concentration of soluble salts in the lower subsoil.

Wherever the soil is properly cultivated and irrigated, it produces excellent yields of barley, flax, grain sorghum, cotton, and alfalfa. Melons and truck crops climatically adapted to the area also do well. Yields of field crops are maintained by crop rotation, occasional fallow periods, and occasional green-manure crops. Cotton is commonly rotated with grain sorghum, but flax and barley are also good crops for rotation with cotton. Melons and truck crops need nitrogen fertilizer in addition to regular fallow periods and crop rotation. A relatively good stand of short annual grasses with some bur-clover and alfileria grows in uncultivated areas and affords pasture for sheep until early summer. About 1½ acres per sheep are required during the grazing season.

Panoche loam, very gently sloping, spotted alkali (Ps).—A number of alkali spots with salt concentration varying from slight to moderate are too small and, in some instances, too numerous to separate on the map. They are therefore grouped as this spotted alkali unit. The area affected by alkali does not exceed 25 percent and in most places is less than 15 percent of the total area mapped as a spotted-alkali unit. This soil is associated with alkali-free areas of Panoche loam and with areas of other Panoche soils slightly affected by alkali.

Crop yields are reduced in proportion to the number and size of alkali spots, and in a few instances tillage becomes a problem because the alkali spots do not dry so soon in spring as the surrounding alkali-free soil. This uneven drying makes it difficult to work alkali-spot areas and alkali-free bodies at the same time. Usually, however, the

soil is worked with other soils of the Panoche series that are free of alkali, and the same management practices are used. Cotton and barley crops are less affected by the spotted alkali condition than flax and vegetable crops. The value for sheep grazing is about the same as for alkali-free areas.

Panoche loam, gently undulating (PQ).—This soil differs from the very gently sloping areas of Panoche loam in having an uneven or hummocky surface that needs more than the usual amount of leveling before it can be properly irrigated. It is deep and friable soil, and leveling can be performed easily without disturbing its fertility or natural productive capacity. Wherever water is available, leveling the soil for irrigation has been profitable. Care is required during irrigation because slopes range from 1 to 3 percent. Gullies form quickly if ditches are too long and have more than a 1- or 2-percent gradient. Short checks and small feeder ditches are recommended, and occasional changes in the location of the main ditches are desirable.

Excellent yields of barley, flax, cotton, grain sorghum, and vegetables adapted climatically to the area are consistently obtained under common management practices. The grazing capacity for sheep is about the same as for the associated very gently sloping areas of Panoche loam and Panoche clay loam.

PANOCHE FINE SANDY LOAM

Panoche fine sandy loam is associated with other soils of the Panoche series on the broad recent alluvial fans. In general, this type occurs near the crest of very low almost imperceptible ridges that mark the general vicinity of old stream channels. The parent material consists of recent alluvium that originated in areas of upland Kettleman soils. The vegetation is short annual grasses.

Because of alkali accumulation in some places and gently undulating relief in others, three separations of Panoche fine sandy loam are shown on the soil map—the very gently sloping; very gently sloping, slight alkali; and gently undulating.

Profile description.—The surface soil has an average depth of 18 inches and consists of light brownish-gray calcareous very friable fine sandy loam. It is underlain by light brownish-gray or light yellowish-brown calcareous fine sandy loam that is generally stratified with thin layers of coarser and finer alluvium. Roots and water easily penetrate the soil, and the degree of stratification normally present only slightly affects the movement of moisture in the subsoil. Below an average depth of 45 inches and extending to undetermined depths, the subsoil is usually a pale-brown or light yellowish-brown friable loam or fine sandy loam that generally contains some segregated lime. Moisture from the low rainfall rarely reaches the deep subsoil. The entire profile is fairly uniform in color but generally stratified.

Use and management.—This soil requires more frequent irrigation for crops than the finer textured Panoche soils, but it is easily tilled and practically impossible to harm by improper tillage. Much of it is planted to barley, flax, cotton, and grain sorghum, and it is an excellent soil for truck crops climatically adapted to the area.

Panoche fine sandy loam, very gently sloping (Po).—Under natural conditions this soil may receive occasional deposits of alluvium,

especially in areas adjacent to shallow drainage channels. The broad slopes of less than 3-percent gradient and the permeable nature of the soil tend to minimize erosion. Where cultivated and irrigated, however, the soil may gully if irrigation water is not carefully applied. The main laterals should have a maximum gradient of less than 2 percent, and feeder ditches should be run parallel to the general contour and on a low gradient.

Under irrigation the soil is well suited to barley, flax, cotton, grain sorghum, and a wide variety of truck crops and melons (pl. 2, *B*) that are climatically adapted to the area. The practices of occasional fallowing, green manuring, crop rotation, and nitrogen fertilization are generally employed and are necessary if high yields are to be maintained over a period of years.

Panoche fine sandy loam, very gently sloping, slight alkali (Pp).—Because this soil contains slight concentrations of alkali it has a slightly lower agricultural value than the very gently sloping unit. Only a small acreage is mapped in the area.

Panoche fine sandy loam, gently undulating (Pn).—Most of this soil is associated with very gently sloping areas of Panoche fine sandy loam. The slope gradient of 1 to 3 percent makes the surface more uneven or hummocky than that of the very gently sloping areas of the type. This soil therefore requires more than usual leveling for irrigation, but in most instances leveling is practical and little damage is done to the soil.

The soil is deep, permeable, and easy to manage. Once it is prepared for irrigation, excellent yields of barley, flax, cotton, grain sorghum, and truck crops may be expected. Care is required in setting the gradient and length of irrigation ditches. About 1½ or 2 acres is required for each sheep grazed.

PANOCHE SILTY CLAY

Panoche silty clay is the heaviest textured of the Panoche series mapped. It occurs extensively toward the outer edges of the broad recent alluvial fans in the central part of the area. It is similar to other Panoche soils except for texture and the greater prevalence of gypsum in the lower subsoil.

Because alkali occurs to some extent, several separations of Panoche silty clay are shown on the soil map.

Profile description.—The 18- to 22-inch surface soil is light brownish-gray or light yellowish-brown calcareous friable silty clay. When dry, the soil cracks into irregular medium-sized blocks that readily break into smaller blocks and granules, but when wet, the soil is very sticky. Moisture is rapidly absorbed and well retained.

The surface soil grades into a similar subsoil, which differs in being pale brown or yellowish brown and in having a somewhat higher gypsum content than is normal for other Panoche soils. The subsoil is calcareous, and in some places lime is segregated in mycelial form. Roots and water easily penetrate deeply. The lower subsoil, extending to a depth in excess of 72 inches, is generally slightly stratified with coarser material such as loam or fine sand and may contain small quantities of gypsum. The entire profile, however, is relatively uniform, and characteristic of the Panoche series.

Use and management.—Most of this soil is cultivated under irrigation. Barley, flax, cotton, and grain sorghum yield well where the alkali concentration is not too high. In uncultivated areas, short annual range grasses with some bur-clover and alfileria afford pasture for sheep in spring.

Panoche silty clay, very gently sloping (Pv).—The relief of this soil is smooth, with a maximum slope of less than 3 percent and an average slope of 1 percent. The slope provides adequate surface drainage for irrigation and little opportunity for erosion under natural conditions. Care should be taken with irrigation ditches to avoid forming damaging gullies.

This alkali-free soil is good for barley, flax, cotton, and grain sorghum under irrigation. Occasional summer fallowing or green manuring and nitrogen fertilization are generally necessary to maintain high yields. Where not cultivated, the soil is used mainly for sheep pasture, and the carrying capacity is similar to that of other Panoche soils.

Panoche silty clay, very gently sloping, slight alkali (Px).—This soil contains slight concentrations of white alkali that are usually distributed evenly throughout the profile. A few areas are included, however, where the salt concentration is moderately strong in the subsoil. Several large bodies of this soil are located in the north-central part of the survey.

The salt content normally affects yields of flax and grain sorghum to a greater extent than barley and cotton. A good quality of irrigation water should be used so that the alkali concentration already present will not be increased. A program of crop rotation, occasional fallowing or green manuring, and nitrogen fertilization is generally necessary to maintain good yields.

Panoche silty clay, very gently sloping, moderate alkali (Pw).—Except for its moderate concentrations of alkali this soil has essentially the same profile characteristics as other Panoche silty clay soils. The salts are fairly evenly distributed throughout the profile and are sufficiently concentrated to reduce crop yields and to limit the range of crops that can be grown successfully. Some success may be had with irrigated grain. One sheep requires 1 to 2 acres for the grazing season.

PANOCHE SILTY CLAY LOAM

Panoche silty clay loam occurs on very gently sloping smooth recent alluvial fans derived from material that originated in areas of Kettleman soils in the uplands to the west. Except for its somewhat lighter and siltier texture, it is in many respects similar to Panoche silty clay.

Two separations of Panoche silty clay loam are made on the basis of alkali content—the very gently sloping; and the very gently sloping, slight alkali.

Profile description.—The light brownish-gray or light yellowish-brown silty clay loam surface soil has an average thickness of 18 inches. It is relatively high in content of silt, mildly calcareous and friable, and easily broken to a medium-sized blocky structure that is readily crushed to a granular mass.

An underlying subsoil extends to undetermined depths and is rather uniformly pale brown or yellowish brown and calcareous. Generally it is of silty clay loam texture, but in a few places the deep subsoil is stratified with somewhat coarser alluvium. This layer usually contains small quantities of gypsum and some segregated lime. Roots and water readily penetrate deeply, and moisture is well retained.

Use and management.—Wherever water is available, the soil is irrigated and intensively cultivated to barley, flax, cotton, and a few truck crops. Uncultivated areas are pastured to sheep and support a fairly good stand of short annual grasses that flourish for a few months in spring.

Panoche silty clay loam, very gently sloping (Py).—Under natural conditions this soil is subject to small intermittent depositions of fine-textured alluvial material by floodwaters rather than to erosion, but if improperly irrigated, it tends to gully. The general relief is smooth (less than 3-percent gradient and averaging 1 percent), and the soil is easily prepared for irrigation. Areas occur in the northwestern corner of the surveyed area.

As this soil does not contain significant quantities of alkali, good to excellent yields are obtained from all crops. Highest yields are consistently maintained when the soil receives occasional summer fallowing or green manuring and nitrogen fertilization. The carrying capacity for sheep is about 1½ acres per head for the 5-month grazing season.

Panoche silty clay loam, very gently sloping, slight alkali (Pz).—Slight concentrations of soluble salts of the white-alkali type are fairly evenly distributed throughout the profile of this soil. Some small spots may be free of alkali. Under irrigation, good yields may be expected from barley and cotton and only slightly reduced yields from flax, grain sorghum, and vegetables. Irrigation water of good quality is important so that additional salts will not be added to the slight concentration already present. The value for grazing is about the same as for areas of very gently sloping Panoche silty clay loam free of alkali.

PANOCHE SANDY LOAM

Panoche sandy loam has the coarsest texture of the Panoche series mapped in the Coalinga area. It occurs close to stream channels on the higher parts of recent alluvial fans. In general landscape this soil corresponds to other Panoche soils.

Two separations of Panoche sandy loam are made on the basis of slope that would affect irrigation. These are the very gently sloping and gently undulating.

Profile description.—The 10- to 30-inch surface soil is light brownish gray, calcareous, and loose. The pale-brown subsoil consists of a calcareous sandy loam or loamy sand that is generally stratified with medium-textured silty sediments that are highly calcareous. Lower in the profile, below depths of 40 inches, the subsoil is more uniform, being light brownish-gray or yellowish-brown fine sandy loam or sandy loam that is calcareous and porous. The loose and generally open subsoil permits excessive internal drainage, and in general the water-holding capacity of this soil is lower than for other soils of the Panoche series.

Use and management.—The soil is well suited to crop production under irrigation, and some of it is cultivated to general field crops. Its use is limited, however, because of its high water requirements in an arid region where the cost of irrigation water is high. The natural cover of short annual range grasses in uncultivated areas affords only fair pasture for sheep even during years of more favorable rainfall.

Panoche sandy loam, very gently sloping (PU).—The smooth slopes of this soil are less than 3 percent in gradient. No appreciable sheet erosion has taken place, but in a few areas adjacent to small drainage channels there has been an occasional deposition of coarse alluvium. This soil is generally associated with Panoche fine sandy loam.

Fallowing at regular intervals and applying nitrogen fertilizer are especially necessary for profitable yields of the common crops grown in the area. As the soil is more permeable and lower in water-holding capacity than the other Panoche soils, irrigation is carried on with more difficulty. Generally 1½ to 2 acres are required to feed one sheep through the grazing season.

Panoche sandy loam, gently undulating (PT).—Gently undulating slopes of 1 to 3 percent and a somewhat hummocky surface characterize this soil. Relatively small bodies are adjacent to stream channels. An area about 3½ miles east of Polvadero Gap has a steeper slope and a more hummocky microrelief than typical. This soil has a stratified loose coarse-textured subsoil that permits excessive internal drainage. The water-holding capacity is low.

Some of this soil is farmed under irrigation, but because of its high water requirements in an arid region where water costs are high, it is doubtful that much of the soil can be profitably leveled for irrigated crops at present. More than the usual amount of leveling is required, but it can be done easily at relatively low cost and without danger of exposing soil material unsuited to crops. The grazing capacity is about the same as on very gently sloping areas of Panoche sandy loam.

RIVERWASH

Riverwash (RA) consists essentially of stratified coarse-textured sands and loose gravel along stream channels and rivers. It is usually of mixed origin and is dominated by the rock materials occurring in the drainage area. The land is nonarable, but some of it is used as a bedding ground for sheep and cattle (pl. 2, *C*). In some places a few trees provide shade for livestock.

SORRENTO GRAVELLY CLAY LOAM

Sorrento gravelly clay loam occurs on recent alluvial material deposited almost entirely by Los Gatos Creek near Coalinga. The parent material consists of gravelly alluvium that originated principally in the areas of hard and partly metamorphosed sandstones and shales lying on the higher Coast Range outside the area to the west. The vegetation is mainly short annual grasses.

Only the gently undulating Sorrento gravelly clay loam is mapped in this area.

Profile description.—The surface soil consists of about 20 inches of brown or pale-brown gravelly noncalcareous clay loam. This ma-

terial is generally friable and permeable but if disturbed when dry tends to bake and to break into slightly hard nutlike aggregates. The wet soil is somewhat browner than the dry soil and, depending upon moisture content, is plastic or sticky. The pebbles are well rounded and average less than one-half inch in diameter.

There is a gradual transition to a calcareous clay loam upper subsoil that contains larger pebbles than the surface soil. This moderately friable material is brown or yellowish brown and has a very weakly developed prismatic structure. The pebbles are held firmly in place when the soil is dry but are easily moved when it is wet. Penetration of roots and water into the deep subsoil is not seriously retarded by this upper subsoil. Below an average depth of 50 inches is yellowish-brown medium- or coarse-textured soil that contains numerous well-rounded pebbles ranging from 1 to 3 inches in diameter. The gravel is generally coated with a thin deposit of lime carbonate. At this lower depth the soil is structureless, and the gravel is loosely held in place.

Sorrento gravelly clay loam, gently undulating (Sc).—Slopes of this soil range from 1 to 3 percent. More than the usual amount of leveling would be required before the soil could be farmed to irrigated crops. Leveling could be performed easily at relatively low cost and without appreciably affecting the inherent fertility and productivity of the soil. The gravel would not interfere seriously with leveling but would somewhat hinder cultivation. The soil is suitable for irrigated barley, flax, beans, and grain sorghum, but none of it is now farmed, mainly because irrigation water is lacking.

SORRENTO CLAY LOAM

Sorrento clay loam has landscape features similar to those of Sorrento gravelly clay loam. It differs mainly in being less gravelly and in having a somewhat higher moisture-holding capacity.

Only one separation of Sorrento clay loam—the gently undulating—has been made in this area.

Profile description.—The noncalcareous surface soil, brown or pale brown, averages 16 inches thick and is normally friable and penetrable by roots and water. It breaks into slightly hard nutlike aggregates if disturbed when dry and is somewhat browner and plastic or sticky when wet.

The underlying upper subsoil extends to depths of less than 40 inches and consists of yellowish-brown or light-brown calcareous clay loam that is very slightly compact and may have a very weakly developed prismatic structure. Roots and water are not seriously retarded by this layer and easily penetrate into the deep friable lower subsoil, a calcareous, structureless, light-brown or light yellowish-brown loam or clay loam generally stratified with sandy or silty sediments.

Sorrento clay loam, gently undulating (Sa).—Like the gently undulating areas of Sorrento gravelly clay loam, this soil also has 1- to 3-percent slopes and a more uneven surface than the typical Sorrento soils. It requires more leveling than normal before it can be farmed under irrigation. Leveling operations could be performed easily, however, and the inherent fertility and productivity would not be

appreciably disturbed. None of this soil is farmed at present, but when leveled and irrigated it would be suitable for barley, flax, beans, grain sorghum, and alfalfa.

SORRENTO FINE SANDY LOAM

Sorrento fine sandy loam has landscape features similar to those of Sorrento gravelly clay loam and Sorrento clay loam.

Only one separation—the gently undulating—has been mapped.

Profile description.—To an average depth of 22 inches the pale-brown or light yellowish-brown surface soil is noncalcareous and friable. It grades into a yellowish-brown noncalcareous friable upper subsoil that is usually of fine sandy loam texture and of weak granular structure. At depths lower than 40 inches, the light yellowish-brown subsoil is slightly calcareous and generally stratified with sandy or silty sediments. It is normally of medium texture, friable, and structureless.

Sorrento fine sandy loam, gently undulating (SB).—This soil requires more than the usual amount of leveling before it can be farmed to an irrigated crop. Leveling can be easily accomplished, and the mixing of the surface soil with the subsoil material will not appreciably affect the productive capacity. None of the soil is cultivated at present, but if it were leveled and irrigated, it would be suitable for barley, flax, beans, alfalfa, and grain sorghum. Slopes range from 1 to 3 percent.

TEMPLE SILTY CLAY

Temple silty clay occurs in a basin position in association with the Merced soils. Under natural conditions it was subject to periodic flooding and supported a rank growth of water-loving grasses and tules. It developed under conditions of and still is affected by a high water table. The relief is nearly level, and surface runoff is very slow. The parent material consists of fine-textured alluvium that originated largely in areas of granitic rocks and that was deposited by slowly moving floodwater from Fresno Slough.

Only one separation of Temple silty clay—the nearly level—is mapped.

Profile description.—The surface soil is characteristically a 10-inch layer of dark-gray to black noncalcareous silty clay that contains a considerable quantity of organic and silty material. The organic-matter content in places approaches that of a muck soil. The soil is very friable and has a soft blocky structure, a low volume weight, and a neutral reaction. Numerous well-preserved root holes and insect borings permeate the surface soil and increase its natural porosity.

The upper subsoil consists of dark-gray intermittently calcareous silty clay that is slightly compact and noticeably stained with colloidal material. Structural aggregates are roughly angular and rather brittle but are easily crushed with slight pressure. There is a fairly high quantity of organic material present, but the volume weight is not so low as for the surface soil. Lower in the profile, to a depth of less than 40 inches, the soil is dark grayish-brown highly calcareous friable clay loam. The organic-matter content is relatively low, and the soil is mottled with rust-brown iron stains. The deep subsoil is generally light olive gray and mottled with rust brown and gray. The subsoil is medium textured and often strati-

fied with micaceous fine sandy sediments. In places it is highly calcareous, containing numerous soft lime blotches and a few hard lime pellets. This subsoil material is similar to that underlying most of the basin soils of the San Joaquin Valley.

Temple silty clay, nearly level (TB).—Much of this soil is adjacent to Fresno Slough along the northeastern boundary of the survey. No injurious concentrations of alkali occur. Most of the soil is cultivated, and in large part the native vegetation of tules and swamp grasses has disappeared. Good yields of barley, cotton, grain sorghum, and alfalfa are obtained where the land is protected from overflow water from Fresno Slough and where the ground water does not remain high for long periods. Adequate surface drainage is maintained by surface drainage ditches supplemented with pumps.

TEMPLE SILTY CLAY LOAM

Temple silty clay loam is similar to Temple silty clay but differs mainly in texture of the surface soil.

Only one separation—the nearly level—is mapped.

Profile description.—The dark-gray neutral surface soil extends to an average depth of 10 inches. It contains a large quantity of organic and silty material, is permeated by numerous root holes and insect borings, and normally is very friable.

The dark-gray intermittently calcareous upper subsoil, to an average depth of 20 inches, is generally fine textured and less friable than the surface soil. Lower in the profile, but above an average depth of 40 inches, is dark grayish-brown clay loam that is highly calcareous, moderately firm, and without definite structure. The organic-matter content is low, and rust-brown iron stains are numerous. The medium-textured deep subsoil is light olive gray mottled with gray stains. It is generally highly calcareous and stratified with micaceous fine sandy material. The lime is usually in the form of soft blotches but occasionally in hard pellets. This lower material is similar to that underlying other basin soils in the region.

Temple silty clay loam, nearly level (TC).—This soil is mostly under cultivation, and, as with other soils of the basin, the native vegetation of tules and swamp grasses has almost completely disappeared. Good yields of barley, cotton, and grain sorghum are obtained on land protected from overflow by levees. The soil is affected by a high water table, particularly during winter, and drainage is maintained by surface ditches and pumps. No harmful concentrations of alkali are present. The soil is inextensive and occurs in the northeastern part of the survey bordering Fresno Slough.

TEMPLE LOAM

Temple loam occurs in basin positions and has general landscape features similar to those of Temple silty clay.

Only one separation of Temple loam—the nearly level—is mapped.

Profile description.—The dark-gray friable and granular loam surface soil extends to an average depth of 10 inches. It is nearly neutral in reaction and contains a large quantity of organic matter and some ash derived from the occasional burning of a rank vegetative cover.

Where the soil is cultivated, the organic material and ash become mixed with the mineral soil and effectively create and maintain a friable condition.

There is a gradual transition from the surface soil to a calcareous loam or clay loam upper subsoil that extends to depths ranging from 16 to 20 inches. The upper subsoil is generally friable, permeable to roots and water, and contains grayish-brown mottlings. Lower in the profile, the light olive-gray soil is mottled, highly calcareous, and usually moist from the fluctuating water table that is characteristic of the basin area. The lower subsoil is friable and generally stratified with loose micaceous sandy material.

Temple loam, nearly level (TA).—The small acreage of this soil occurs in the northeastern part of the survey. In other sections of the valley outside the Coalinga area, Temple loam, nearly level, occurs in larger bodies and is one of the more productive basin soils. The principal factors limiting cultivation of this soil, as for other basin soils, are a high water table and occasional flooding. Ditches and pumps maintain adequate drainage. Grain sorghum, barley, and cotton normally produce good yields. The soil is excellent for alfalfa or for pasture forage crops for dairy stock.

RELATIVE SUITABILITY OF SOILS FOR AGRICULTURE

The objective of efficient land use and soil management is to insure a good income over a period of years and at the same time maintain soil productivity. This requires using the land for the purpose or purposes to which it is best suited, adopting suitable types of farming, growing those crops best adapted, and using irrigation, crop rotations, tillage practices, applications of manure and fertilizer, and other methods of soil management that will maintain or increase the fertility of the soil and minimize erosion. To practice good soil management the farmer needs to consider a soil's good points and its deficiencies, making use of the good features and overcoming the poor ones.

Because of the low annual rainfall and rainless summers in the Coalinga area, all crops, except a relatively small acreage of dry-farmed grains, are grown on irrigated land. Water for irrigation is available only for the lower lying land where slopes seldom exceed 2 or 3 percent. Aside from water supply, the principal modifying or limiting factors in determining suitability for the various crops are drainage, accumulation of salts, and the depth, texture, and structure of surface soil and subsoil. Erosion is of little importance on the cultivated soils, but it is important on the upland soils where intensive sheep grazing has resulted in moderate to severe erosion in a number of places.

Other factors that influence productivity to some degree, especially under irrigation, are inherent fertility of the soil, the content of organic matter, soil reaction, and lime content. These factors determine to a considerable extent the adaptation of individual crops and the management required to maintain fertility.

Crop management, involving soil and irrigation management directly related to specific crops, is given in the section on Agriculture. Management practices for alkali soils are given in the section on Alkali, and practices for those soils susceptible to erosion are given in the section on Erosion. Important characteristics of the soils, which

largely govern their use, are given in brief relative descriptive terms in the supplement to the soil map, cover page 3. A more detailed discussion of soil-crop relations for each soil is given in the section on Soil Descriptions.

The soils of the Coalinga area are listed in table 4 according to the Storie index (*8*, *12*). This index expresses numerically the relative degree of physical suitability a soil has, or its value for general intensive agriculture. Factors that govern present and potential use and the productive capacity of a soil are included, but this index is determined by soil conditions only. The index is independent of other physical or economic factors that might determine the desirability of growing certain plants in a given locality, and by itself is not an index for land evaluation.

Four general factors are considered in the index rating for a soil: (A) Character of the soil profile and soil depth; (B) texture of the surface soil; (C) slope; and (X) less permanent factors such as drainage, alkali, and erosion. Each of these factors is evaluated on the basis of 100 percent for the most favorable or ideal condition, with limiting maximum and minimum ratings ascribed to conditions that are less favorable to plant growth The index rating is obtained by multiplying the factors, $A \times B \times C \times X$; thus any one factor may dominate or control the final rating. For example, a soil may have an excellent profile condition warranting a rating of 100 percent for factor A, excellent surface soil conditions warranting 100 percent for factor B, a smooth nearly level surface warranting 100 for factor C, but a high accumulation of salts that would give a rating of 10 percent for factor X. Multiplied together, these four ratings give 10 percent as the index for this soil. The high accumulation of salts dominates the quality of the soil and renders it wholly unproductive for crops in its present state, thus justifying the index of 10.

TABLE 4.—*Index ratings for soils of the Coalinga area, Calif.*

Soil	Index rating factors [1]				Index rating	Grade and subgrade
	A	B	C	X		
Kettleman loam:						
Gently undulating	60	100	95	100	57	3B
Undulating	60	100	90	100	54	3B
Rolling	45	100	85	100	38	4B
Hilly, eroded	35	100	75	[2] 75	20	4B
Steep, eroded	35	100	30	[2] 75	8	6B
Kettleman clay loam:						
Undulating	60	85	90	100	46	3B
Rolling	50	85	85	100	36	4B
Hilly, eroded	40	85	75	[2] 75	19	5B
Steep, eroded	40	85	30	[2] 75	8	6B
Kettleman fine sandy loam:						
Gently undulating	60	100	95	100	57	3B
Gently sloping	60	100	95	100	57	3B
Undulating	60	100	90	100	54	3B
Rolling	45	100	85	100	38	4B
Hilly, eroded	35	100	75	[2] 75	20	4B
Steep, eroded	35	100	30	[2] 75	8	6B

See footnotes at end of table.

TABLE 4.—*Index ratings for soils of the Coalinga area, Calif.*—Con.

Soil	Index rating factors [1]				Index rating	Grade and subgrade
	A	B	C	X		
Kettleman sandy loam:						
Gently undulating	60	95	95	100	54	3B
Undulating	60	95	90	100	51	3B
Rolling	45	95	85	100	36	4B
Hilly, eroded	35	95	75	[2] 75	19	5B
Steep, eroded	35	95	30	[2] 75	8	6B
Kettleman silty clay loam:						
Undulating	50	90	95	100	43	3B
Rolling	50	90	85	100	38	4B
Kettleman-Linne complex:						
Rolling	50	70	85	100	30	4B
Hilly, eroded	40	70	75	[2] 75	16	5B
Steep, eroded	40	40	30	[2] 75	4	6B
Lethent silty clay:						
Nearly level, slight alkali	80	70	100	[3] 80	45	3A
Nearly level, moderate alkali	80	70	100	[4] 50	28	4A
Nearly level, moderately strong alkali	80	70	100	[5] 30	17	5A
Nearly level, strong alkali	80	70	100	[6] 12	7	6A
Lethent silty clay loam:						
Nearly level, slight alkali	80	90	100	[3] 80	58	3A
Nearly level, moderate alkali	80	90	100	[4] 50	36	4A
Nearly level, strong alkali	80	90	100	[6] 12	9	6A
Hummocky, slight alkali	80	90	95	[3] 80	55	3A
Hummocky, moderate alkali	80	90	95	[4] 50	34	4A
Levis silty clay, nearly level, strong alkali	95	70	100	[6] 12	8	6A
Lost Hills fine sandy loam:						
Very gently sloping	85	100	100	[7] 90	77	2A
Gently undulating	85	100	95	[7] 90	73	2A
Undulating	85	100	90	[7] 90	69	2A
Lost Hills clay loam:						
Very gently sloping	85	85	100	[7] 90	65	2A
Gently undulating	85	85	95	[7] 90	62	2A
Undulating	85	85	90	[7] 90	59	3B
Lost Hills loam:						
Very gently sloping	85	100	100	[7] 90	76	2A
Gently sloping	85	100	95	[7] 90	73	2A
Merced clay (adobe):						
Nearly level	70	60	100	[8] 80	34	4A
Nearly level, slight alkali	70	60	100	[9] 64	27	4A
Nearly level, moderately strong alkali	70	60	100	[10] 24	10	5A
Merced clay loam, nearly level, spotted alkali	70	85	100	[11] 68	40	3A
Merced silty clay loam, shallow over Lethent silty clay:						
Nearly level, spotted alkali	70	90	100	[11] 68	43	3A
Nearly level, moderately strong alkali	70	90	100	[10] 24	15	5A
Oil-waste land	-----	-----	-----	-----	[12] 5	6B
Ortigalita clay loam, gently undulating	80	85	95	[7] 90	58	3B
Oxalis silty clay:						
Nearly level, slight alkali	95	70	100	[9] 81	54	3A
Nearly level, moderate alkali	95	70	100	[13] 45	30	4A
Panhill fine sandy loam:						
Very gently sloping	100	100	100	100	100	1A
Gently undulating	100	100	95	[7] 95	90	1A

See footnotes at end of table.

TABLE 4.—*Index ratings for soils of the Coalinga area, Calif.*—Con.

Soil	Index rating factors [1]				Index rating	Grade and subgrade
	A	B	C	X		
Panhill loam:						
Very gently sloping	100	100	100	100	100	1A
Very gently sloping, slight alkali	100	100	100	[3] 90	90	1B
Gently undulating	100	100	95	[7] 95	90	1A
Panhill sandy loam:						
Very gently sloping	100	95	100	100	95	1A
Gently undulating	100	95	95	[7] 95	86	1A
Panhill clay loam:						
Very gently sloping	95	85	100	100	81	1A
Gently undulating	95	85	95	[7] 95	73	2A
Panoche clay loam:						
Very gently sloping	100	85	100	100	85	1A
Very gently sloping, slight alkali	100	85	100	[3] 90	77	2B
Very gently sloping, moderate alkali	100	85	100	[4] 60	51	3A
Gently undulating	100	85	100	[7] 95	81	1A
Panoche loam:						
Very gently sloping	100	100	100	100	100	1A
Very gently sloping, spotted alkali	100	100	100	[14] 80	80	1B
Gently undulating	100	100	100	[7] 95	95	1A
Panoche fine sandy loam:						
Very gently sloping	95	100	100	100	95	1A
Very gently sloping, slight alkali	95	100	100	[3] 90	86	1B
Gently undulating	95	100	100	[7] 95	90	1A
Panoche silty clay:						
Very gently sloping	100	70	100	100	70	2A
Very gently sloping, slight alkali	100	70	100	90	63	2B
Very gently sloping, moderate alkali	100	70	100	60	42	3A
Panoche silty clay loam:						
Very gently sloping	100	90	100	100	90	1A
Very gently sloping, slight alkali	100	90	100	90	81	1B
Panoche sandy loam:						
Very gently sloping	90	95	100	100	86	1A
Gently undulating	90	95	100	[7] 95	81	1A
Riverwash	-----	-----	-----	-----	[12] 5	6B
Sorrento gravelly clay loam, gently undulating	95	80	95	100	72	2A
Sorrento clay loam, gently undulating	95	85	95	100	77	2A
Sorrento fine sandy loam, gently undulating	95	100	95	100	90	1A
Temple silty clay, nearly level	95	70	100	[8] 80	53	3A
Temple silty clay loam, nearly level	95	90	100	[8] 80	68	2B
Temple loam, nearly level	95	100	100	[8] 80	76	2B

[1] A, Soil depth and character of profile; B, texture of surface soil; C, slope; and X, less permanent factors.
[2] Moderately to severely eroded.
[3] Slight alkali.
[4] Moderate alkali.
[5] Moderately strong alkali.
[6] Strong alkali.
[7] Low hummocky microrelief.
[8] Imperfect drainage.
[9] Imperfect drainage and slight alkali.
[10] Imperfect drainage and moderately strong alkali.
[11] Imperfect drainage and spotted alkali.
[12] Estimated range not obtained by use of factors.
[13] Imperfect drainage and moderate alkali.
[14] Spotted alkali.

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According to their index ratings, the soils are placed in six grades. The soil grade and the index rating refer to the degree of physical suitability of the soil for general intensive agriculture. Grade 1 soils are excellent soils well suited to general intensive agriculture and range in index rating from 80 to 100. They are easily worked, productivity is relatively easy to maintain or improve, irrigation can be carried on simply and efficiently, and no special erosion-control practices are required.

Grade 2 soils are moderately well suited to general intensive agriculture and range in rating from 60 to 80. Irrigation can be carried on simply and efficiently, and no special erosion-control practices are required. The ranges for crops and yields are somewhat less than for grade 1 soils.

Grade 3 soils are only fairly well suited, and range in rating from 40 to 60. The ranges for crops and yields are less than for grade 2 soils, and the productivity is more difficult to improve.

Grade 4 soils are poorly suited to crops and range in rating from 20 to 40; grade 5 soils are very poorly suited and range in rating from 10 to 20. Grade 4 and 5 soils have a narrow range for crops and produce low yields; they are generally marginal land.

Grade 6 consists of nonagricultural soils and land types that have ratings less than 10.

In addition to the grades mentioned, soils have been placed in subgrades on the basis of the general nature of the limitations affecting use.

In table 5 the soils of the Coalinga area are arranged in groups according to soil grade and subgrade, and the suitability of each soil for each of the principal crops is given in relative descriptive terms. The production of a crop on soils of good or very good suitability for that crop should be successful if crop and farm management practices common in the area are followed and prices are normal.

Table 6 gives expectable average acre yields of crops in the area according to crop suitability terms used in table 5.

ALKALI

The term "alkali" refers to concentrations of soluble salts in the soil that may injuriously affect the growth of economic plants. In general, the main factors responsible for accumulation of alkali in the Coalinga area soils are aridity of climate, high salt content in the parent rock from which the soils are derived, high ground water level, and high rate of evaporation during long dry summers that results in the capillary rise of water and salts to the surface.

The so-called white alkali is dominant in this area; it consists mainly of neutral salts, as sodium chloride (common salt) and sodium sulfate (Glauber's salt). The chloride is probably the more toxic of the two salts, but the sulfate is by far the more predominant in this area. The pH of soils containing these salts is less than 8.5.

A relatively small area in the northeastern part of the survey contains some spots of black alkali, which includes the alkaline and more toxic salts of sodium bicarbonate and sodium carbonate. The pH of soils containing these salts is greater than 8.5, causing the soils to be strongly to very strongly alkaline. The soil aggregates tend

TABLE 5.—*Relative suitability of irrigated soils for general intensive agriculture and for principal crops*[1] *in the Coalinga area, Calif.*

Soils and subgrades[2]	Cotton	Alfalfa	Flaxseed	Melons	Truck crops	Grain sorghum	Wheat		Barley		Guayule[3]	Pasture, seeded	Pasture range, nonirrigated
							Irrigated	Nonirrigated	Irrigated	Nonirrigated			
GRADE 1: SOILS WELL SUITED TO GENERAL INTENSIVE AGRICULTURE													
Subgrade 1A: Soils without significant limitations to production of most crops commonly grown.													
Panhill loam:													
Very gently sloping	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Poor	Very good	Poor	Very good	Very good	Fair.
Gently undulating	Good	Good	Good	Good	Good	Good	Good	do	Good	do	Good	Good	Do.
Panhill fine sandy loam:													
Very gently sloping	do	Very good	do	Very good	Very good	do	do	do	do	do	Very good	do	Do.
Gently undulating	do	Good	do	Good	Good	do	do	do	do	do	Good	do	Do.
Panhill sandy loam:													
Very gently sloping	do	do	Fair	Very good	do	Fair	do	do	Fair	do	do	Fair	Do.
Gently undulating	Fair	do	do	Good	do	do	do	do	Good	do	Fair	do	Do.
Panhill clay loam, very gently sloping	Good	Very good	Very good	do	do	Very good	Very good	do	Very good	do	Good	Very good	Do.
Panoche loam:													
Very gently sloping	Very good	do	do	Very good	Very good	do	do	do	do	do	Very good	do	Do.
Gently undulating	Good	Good	Good	Good	Good	Good	Good	do	Good	do	Good	Good	Do.
Panoche fine sandy loam:													
Very gently sloping	do	Very good	do	Very good	Very good	do	do	do	do	do	Very good	do	Do.
Gently undulating	do	Good	do	Good	Good	do	do	do	do	do	Good	do	Do.
Panoche sandy loam:													
Very gently sloping	do	do	Fair	Very good	do	Fair	do	do	do	do	do	Fair	Do.
Gently undulating	Fair	do	do	Good	do	do	do	do	do	do	Fair	do	Do.
Panoche clay loam:													
Very gently sloping	Very good	Very good	Very good	do	do	Very good	Very good	do	Very good	do	Good	Very good	Do.
Gently undulating	Good	Good	Good	Fair	do	Good	Good	do	Good	do	Fair	Good	Do.
Panoche silty clay loam, very gently sloping.	Very good	Very good	Very good	Good	do	Very good	Very good	do	Very good	do	Good	Very good	Do.
Sorrento fine sandy loam, gently undulating.	Good	Good	Fair	do	do	Fair	Good	do	Good	do	Fair	Good	Do.
Subgrade 1B: Soils nearly as well suited to as many crops as subgrade 1A soils, but some care is required in use to prevent increase in soluble salt (alkali) concentration.													
Panhill loam, very gently sloping, slight alkali	do	do	Good	do	Fair	Good	Very good	do	Very good	do	Good	Very good	Do.
Panoche loam, very gently sloping, spotted alkali	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Panoche fine sandy loam, very gently sloping, slight alkali.	do	do	do	do	do	do	Good	do	Good	do	do	Good	Do.
Panoche silty clay loam, very gently sloping, slight alkali.	do	do	do	Fair	do	do	Very good	do	Very good	do	Fair	Very good	Do.
GRADE 2: SOILS MODERATELY WELL SUITED TO GENERAL INTENSIVE AGRICULTURE													
Subgrade 2A: Well-drained heavy-textured soils of rather low permeability but fairly high water-holding capacity or soils with moderately compact subsoils. Moderately well suited to most field and truck crops.													
Lost Hills loam:													
Very gently sloping	Good	Good	Good	Good	Good	Good	Very good	Poor	Very good	Poor	Poor	Very good	Fair.
Gently sloping	Fair	do	do	do	do	Fair	Good	do	Good	do	do	Good	Do.
Lost Hills fine sandy loam:													
Very gently sloping	Good	do	do	do	do	Good	do	do	do	do	Fair	Very good	Do.
Gently undulating	do	do	Fair	do	do	do	do	do	do	do	Poor	Good	Do.
Undulating	Fair	Fair	do	Fair	Fair	Fair	do	do	do	do	do	do	Do.
Lost Hills clay loam:													
Very gently sloping	do	Good	Good	do	do	Good	Very good	do	Very good	do	do	Very good	Do.
Gently undulating	do	do	Fair	do	do	do	Good	do	Good	do	Very poor	Good	Do.
Panhill clay loam, gently undulating	Good	do	Good	do	Good	do	do	do	do	do	Fair	do	Do.
Panoche silty clay, very gently sloping	do	do	Very good	do	Fair	Very good	Very good	do	Very good	do	do	Very good	Do.
Sorrento clay loam, gently undulating	do	do	Good	do	do	Good	Good	do	Good	do	do	Good	Do.
Sorrento gravelly clay loam, gently undulating.	do	do	Fair	do	do	do	do	do	do	do	do	do	Do.
Subgrade 2B: Imperfectly drained soils or soils slightly affected with soluble salts (alkali). Productivity may be increased for some soils through alkali reclamation, although reclamation is somewhat more difficult than for subgrade 1B soils.													
Panoche clay loam, very gently sloping, slight alkali.	do	do	Good	do	do	do	Very good	do	Very good	do	do	Very good	Do.
Panoche silty clay, very gently sloping, slight alkali.	do	do	do	do	do	do	do	do	do	do	Poor	do	Do.
Temple loam, nearly level	do	do	do	do	Good	Very good	do	Fair	do	Fair	do	do	Good.
Temple silty clay loam, nearly level	do	do	do	do	Fair	do	do	do	do	do	do	do	Do.
GRADE 3: SOILS ONLY FAIRLY WELL SUITED TO GENERAL INTENSIVE AGRICULTURE													
Subgrade 3A: Imperfectly or poorly drained soils and soils containing some concentration of soluble salts (alkali). Fairly well suited to field crops and well suited to irrigated pasture. In most cases it is feasible to improve productivity by drainage and alkali reclamation.													
Lethent silty clay loam:													
Nearly level, slight alkali	Fair	Fair	Fair	Poor	Poor	Fair	Good	Poor	Good	Poor	Very poor	Good	Fair.
Hummocky, slight alkali	do	do	do	do	do	Poor	Fair	do	Fair	do	do	do	Do.
Lethent silty clay, nearly level, slight alkali.	do	do	do	do	do	Fair	Good	do	Good	do	do	do	Do.
Merced clay loam, nearly level, spotted alkali.	do	do	do	do	do	do	do	do	do	do	Poor	do	Good.
Merced silty clay loam, shallow over Lethent silty clay, nearly level, spotted alkali.	do	Poor	do	do	do	do	do	do	do	do	do	do	Fair.
Oxalis silty clay, nearly level, slight alkali.	Good	Fair	Good	do	Fair	do	Very good	do	Very good	do	do	Very good	Do.
Panoche clay loam, very gently sloping, moderate alkali.	Fair	do	Fair	do	Poor	do	Good	do	Good	do	do	Good	Do.
Panoche silty clay, very gently sloping, moderate alkali.	do	Poor	do	do	do	do	do	do	do	do	Very poor	do	Do.
Temple silty clay, nearly level	Good	Fair	do	do	Fair	Good	Very good	Fair	Very good	Fair	Poor	Very good	Good.
Subgrade 3B: Gently sloping to undulating deep to moderately deep soils that can be irrigated, but for which special practices are necessary. Practices for erosion control necessary in most places where cultivated. A water supply for irrigation has not been developed for these soils.													
Kettleman loam:													
Gently undulating	Poor	do	do	Fair	do	Fair	Fair	Poor	Fair	Poor	Very poor	Good	Fair.
Undulating	do	do	do	do	do	Poor	do	do	do	do	do	Fair	Do.
Kettleman fine sandy loam:													
Gently undulating	do	do	Poor	do	do	Fair	do	do	do	do	do	Good	Do.
Gently sloping	do	do	do	do	do	do	do	do	do	do	do	Fair	Do.
Undulating	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Kettleman sandy loam:													
Gently undulating	do	do	do	do	do	Poor	do	do	do	do	do	do	Do.
Undulating	do	do	do	Poor	Poor	do	do	do	do	do	do	do	Do.
Kettleman clay loam, undulating	do	do	Fair	Fair	Fair	Fair	do	do	do	do	do	Good	Do.
Kettleman silty clay loam, undulating	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Lost Hills clay loam, undulating	Fair	do	do	Poor	Poor	do	do	do	do	do	do	do	Do.
Ortigalita clay loam, gently undulating	do	do	do	Fair	Fair	do	Good	do	Good	do	Poor	do	Do.
GRADES 4 AND 5: SOILS POORLY AND VERY POORLY SUITED TO GENERAL INTENSIVE AGRICULTURE													
Subgrades 4A and 5A: Imperfectly or poorly drained soils, mostly heavy textured, rather difficult to work, and generally containing slight to moderately strong concentrations of soluble salts (alkali). Alkali reclamation difficult.													
Lethent silty clay loam:													
Nearly level, moderate alkali	Poor	Poor	Poor	Very poor	Very poor	Poor	Fair	Poor	Fair	Poor	Very poor	Good	Fair.
Hummocky, moderate alkali	Fair	Fair	do	do	do	do	Poor	do	Poor	do	do	Fair	Do.
Lethent silty clay:													
Nearly level, moderate alkali	do	do	do	do	do	do	Fair	do	Fair	do	do	Good	Do.
Nearly level, moderately strong alkali.	Very poor	Very poor	Very poor	do	do	Very poor	Poor	Very poor	Poor	Very poor	do	Fair	Do.
Merced clay (adobe):													
Nearly level	Fair	Poor	Fair	Poor	Poor	Fair	Good	Poor	Good	Poor	Poor	Good	Good.
Nearly level, slight alkali	do	do	do	do	do	do	Fair	do	Fair	do	do	do	Do.
Nearly level, moderately strong alkali.	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Poor	do	Poor	Very poor	Very poor	Fair	Fair.
Merced silty clay loam, shallow over Lethent silty clay, nearly level, moderately strong alkali.	do	do	do	do	do	do	do	Very poor	do	do	do	do	Do.
Oxalis silty clay, nearly level, moderate alkali.	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Fair	Poor	do	Good	Do.
Subgrades 4B and 5B: Rolling to hilly soils that can be irrigated only by very special practices. Over a long period of time best suited to range pasture, but management to prevent overstocking and consequent erosion is necessary. These soils are not cultivated, and there is little likelihood of development of a water supply for irrigation.													
Kettleman loam:													
Rolling	Very poor	Fair	Poor	do	do	do	Poor	do	Poor	do	do	Fair	Do.
Hilly, eroded	do	Very poor	Very poor	Very poor	Very poor	Very poor	do	do	do	do	do	Poor	Poor.
Kettleman fine sandy loam:													
Rolling	do	Poor	do	Poor	Poor	Poor	do	do	do	do	do	Fair	Fair.
Hilly, eroded	do	Very poor	do	Very poor	Very poor	Very poor	do	do	do	do	do	Poor	Poor.
Kettleman sandy loam:													
Rolling	do	Poor	do	Poor	Poor	do	do	do	do	do	do	do	Fair.
Hilly, eroded	do	Very poor	do	Very poor	Very poor	do	Very poor	Very poor	Very poor	Very poor	do	do	Poor.
Kettleman clay loam:													
Rolling	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	do	Fair	Fair.
Hilly, eroded	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	do	do	do	do	do	Poor	Poor.
Kettleman silty clay loam, rolling	Poor	Fair	Poor	Poor	Poor	Poor	do	do	do	do	do	Fair	Fair.
Kettleman-Linne complex:													
Rolling	do	Poor	do	do	do	do	do	do	do	do	do	do	Do.
Hilly, eroded	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	do	do	do	do	do	Poor	Poor.
GRADE 6: NONAGRICULTURAL SOILS AND LAND TYPES													
Subgrade 6A: Soils containing strong concentrations of soluble salts (alkali).													
Lethent silty clay loam, nearly level, strong alkali.	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Poor	Poor.
Lethent silty clay, nearly level, strong alkali.	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Levis silty clay, nearly level, strong alkali.	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Subgrade 6B: Steep eroded shallow soils and nonagricultural land types.													
Kettleman loam, steep, eroded	do	do	do	do	do	do	do	do	do	do	do	Very poor	Very poor.
Kettleman fine sandy loam, steep, eroded.	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Kettleman sandy loam, steep, eroded	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Kettleman clay loam, steep, eroded	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Kettleman-Linne complex, steep, eroded	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Riverwash	do	do	do	do	do	do	do	do	do	do	do	do	Do.
Oil-waste land	do	do	do	do	do	do	do	do	do	do	do	do	Do.

[1] Crops are irrigated except where specified as nonirrigated.

[2] Soil grades are based on degree of physical suitability for general intensive agriculture and on the general nature of significant soil limitations for crop production.

[3] Suitability of soils for guayule taken from processed report, Classification of Soils for Guayule, Coalinga area, California, by Emergency Rubber Project, U. S. Forest Service.

TABLE 6.—*Expectable average acre yields*[1] *of crops in the Coalinga area, Calif., ac*
terms given in table 5

Irrigated crop	Unit	Crop s		
		Very good	Good	Fair
		More than—		
Cotton	100-pound lint	9	6–9	3–6
Alfalfa	Tons	6½	5–6½	3½–5
Flaxseed	110-pound, or 2-bushel, sacks	12	8–12	4–8
Cantaloups	Tons	8	6–8	4–6
Carrots	Tons (with tops)	12	9–12	6–9
Tomatoes	Tons	12	8–12	5–8
Grain sorghum	110-pound, or 2-bushel, sacks	30	22–30	14–22
Wheat	120-pound, or 2-bushel, sacks	18	13–18	8–13
Wheat, nonirrigated	do	12	9–12	5–9
Barley	100-pound, or 2-bushel, sacks	25	18–25	11–18
Barley, nonirrigated	do	16	12–16	7–12
Pasture, seeded [2]	Cow-acre-days [3]	400	300–400	200–300
Pasture, range, nonirrigated [4]	do	50	25–50	15–25

[1] Obtainable under present management practices.
[2] Ladino clover is generally the main constituent.
[3] Cow-acre-days is used to express the carrying capacity or grazing value of pasture or range lands. It is the product of the number of animal units to the acre multiplied by the number of days that animals can be grazed withou is a mature cow, steer, or hor
[4] Natural forage in open h valley floor.

to become deflocculated and the soil tighter than where only neutral salts are present.

Concentrations of white alkali are almost always associated with high concentrations of calcium sulfate (gypsum). Gypsum has been observed even in profiles containing some black alkali. The type of alkali and the fact that it is concentrated mainly in the subsoil in association with gypsum result in somewhat less injury to shallow-rooted crops than in areas of the same grade of alkali accumulation in many other parts of the San Joaquin Valley, particularly the eastern parts. High salt concentrations in the subsoil, however, limit the agricultural use of the soils to shallow-rooted crops and are a potential source of salts for the surface soils. If adequate drainage is not maintained, the salts tend to rise and accumulate in the root zone.

Much of the upland from which most of the alluvial soils of the area are derived consists of highly calcareous and gypsiferous softly consolidated sandstone and shale in which relatively large quantities of soluble salts occur inherently. Because of the salt content of the parent rock, it is not surprising that even the well-drained alluvial soils having their origin in this material contain some salt.

The fine-textured soils deposited on the lower and more level parts of the fans have slow surface drainage, and in such areas salts are most likely to occur in excessive quantities. None of the west-side streams of the area have channels extending to Fresno Slough; consequently, their floodwaters are absorbed or retained on the more level slopes until removed by evaporation and transpiration. Any salts contained in these waters accumulate in the soils through years of alternate flooding and drying. This natural accumulation of salts has taken place particularly in soils of the Levis and Lethent series and to a less extent in soils of the Oxalis series.

The quantity and chemical character of the salts in irrigation water is another important factor in the development of alkali soils. A large part of the cultivated area of this survey is irrigated by water pumped from deep wells, and a relatively small acreage is supplied during flood season with water from small intermittent streams draining the foothills. Wherever salts from these waters have accumulated, only white alkali soils have formed. An important acreage in the northeastern part of the area is irrigated by water from the Kings River by way of Fresno Slough and auxiliary canals. This water originates in the Sierra Nevada Range and normally contains less salt than well water or stream water from the hills on the west side of the San Joaquin Valley. The results of chemical analyses of a number of well water samples throughout the area are presented in table 7 in the section on Water Supply and Irrigation. It will be observed that the well water is relatively high in salts and in some cases is of questionable quality for irrigation.

The methods of preventing accumulation of alkali in irrigated areas vary with the factors promoting its accumulation. In general, preventive practices involve (1) development of adequate drainage, (2) avoidance of excess use of irrigation water, (3) lining of canals to prevent seepage, and (4) use of good quality irrigation water.

The methods of reclaiming alkali soils depend on the kinds of salts present and the type of soil to be reclaimed. Factors to be con-

sidered in alkali reclamation (*2*) are composition of the soluble salt, drainage, composition of irrigation water, nature and content of minerals in the soil, and content of replaceable sodium in the soil. The fact that a soil may have a high content of alkali is not necessarily a factor limiting its reclamation and utilization. The character of the soil profile and its probable crop-producing ability when free of alkali, however, should be considered before reclamation is undertaken. Of paramount importance to successful alkali reclamation is the establishment of permanent and adequate drainage.

In the Coalinga area, four principal grades of alkali accumulation are mapped—slight or spotted, moderate, moderately strong, and strong. These are used in mapping units of the soil types affected by alkali. Differences in grade of alkali accumulation in the same soil type are shown by a regular soil boundary, and the alkali grade is shown as part of the soil symbol. In this respect, alkali accumulations are shown differently on the soil map for this survey than for preceding surveys in the San Joaquin Valley. In earlier surveys in this valley alkali accumulations are shown by a separate line and a symbol in red. The locations of the principal soils affected by alkali in the Coalinga and Mendota areas are shown in figure 5.

For shallow-rooted crops there is little difference in production between soils free of alkali and the same soils slightly affected. A greater difference would be noticed if the crops were deep rooted. Soils with spotty alkali accumulations have occasional patches where crops fail or are stunted. Soils moderately affected with alkali produce a noticeably smaller crop yield than soils free or only slightly affected, and areas with moderately strong alkali generally produce low yields, even of shallow-rooted crops. In areas of moderately strong alkali accumulation the surface soil may be only slightly or moderately affected, whereas the subsoil is strongly affected. Most areas having strong alkali concentration are not cultivated but used principally for range pasture.

In the soil survey of Kings County (*6*), Panoche and Kettleman soils are mapped as weakly affected with alkali. The gypsum content of these soils results in a total soluble salt content closely approaching a quantity normally considered significant in crop production. In this survey, Panoche and Kettleman soils—soils of low soluble salt content, of which dissolved gypsum is the main constituent—are not considered significantly affected with salt. This results in an apparent discrepancy between the two surveys in the mapping of alkali.

The type of natural vegetation, character of crop growth, and certain structural features of the soil are general indicators of the degree of alkali concentration in the soil. These indicators are checked and correlated with the percentage of total salts in the air-dry soil as determined in the field by a modified Wheatstone electrolytic bridge, following the procedure in the Soil Survey Manual (*4*). In the laboratory some of the soil samples were further subjected to qualitative tests as to kind of salts. A simple color reaction with phenolphthalein was used as a field indicator for the presence of black alkali; this determination was later checked in the laboratory by qualitative analysis.

During the course of this survey, more than 1,600 soil samples from 525 different soil profiles throughout the area were collected for alkali

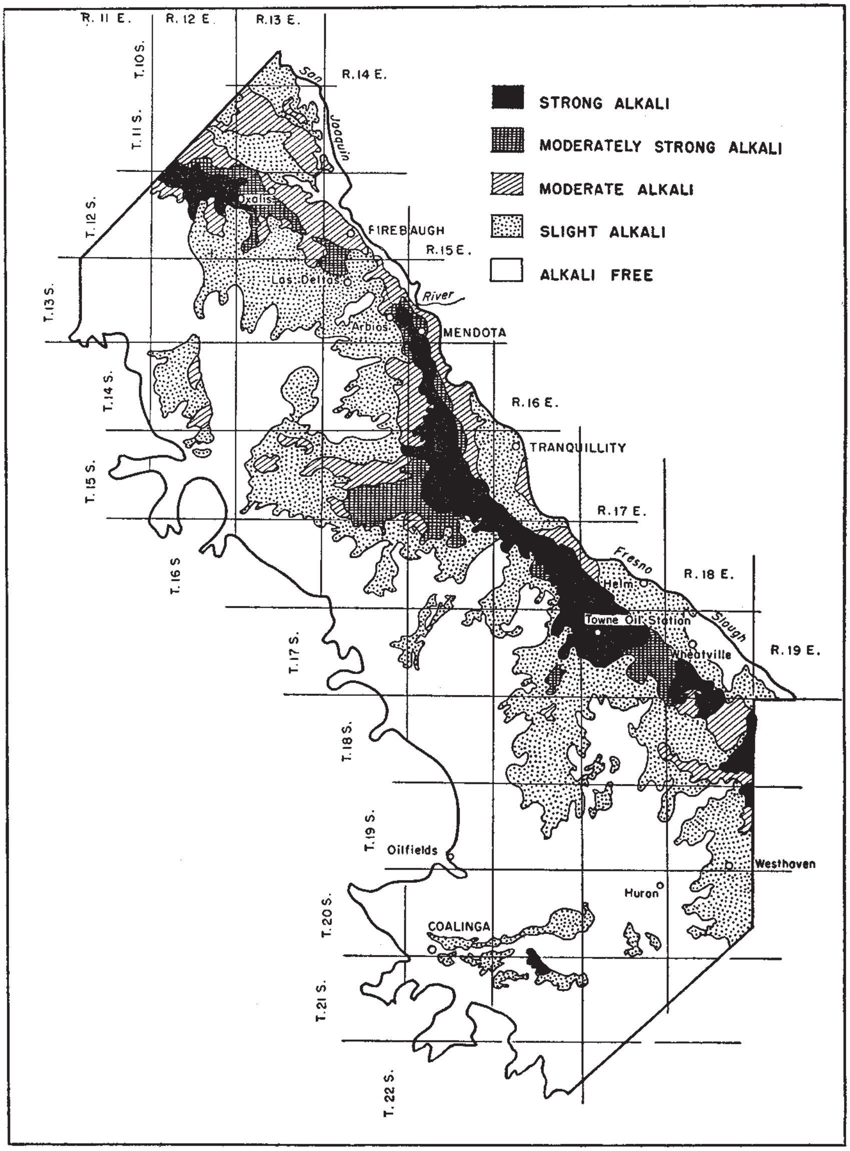

FIGURE 5.—Distribution of alkali in soils in the Coalinga and Mendota areas, Calif.

determinations. The results of these determinations appear on the soil map in the form of red fractions at the places (designated by a dot before the fraction) where the samples were collected. The numerator of the fraction is the percentage of salts in the surface soil; the denominator is the percentage of salts in the subsoil. All fractions denote white alkali unless the red letter, B, indicating black alkali, appears to the right of a fraction.

WATER SUPPLY AND IRRIGATION [14]

The average yearly rainfall is only about 7 inches. Many storms yield less than half an inch of rain. Precipitation contributes little moisture to the soil. Stream flow is likewise not an important source of water supply. The few creeks on the east slope of the Coast Range have watersheds of small area, and since the rainfall is normally light, there is little runoff. Occasional floods occur because the creeks do not have well-defined channels on the plains and allow floodwaters to spread over large areas. When such overflows occur, a limited acreage receives enough additional water to produce a crop of barley. A few dikes have been built in places to control floodwater and to spread it more uniformly.

The uncertainty of the floodwater supply, the limited area affected, and the low rainfall have made it necessary to tap ground water underlying the valley for an adequate supply of irrigation water. Deep-well pumps have been largely responsible for the recent extension of irrigation (pl. 3, *B*). An ample reserve of ground water is in the valley fill beneath the area, but its use is limited by the high pumping lift. There are no important sources of water for recharge. It is reported that ground water from the abundant supply on the east side of the San Joaquin Valley cannot come into this area because the water-bearing formations are not continuous across the valley. During the period for which records are available, there has been an average drop of 5 feet in the water level throughout the pumping area. The rate of drop will decrease if no new lands are irrigated, because more and more water will come in from surrounding areas as the depression caused by pumping increases. If this past rate of drop continues for the next 10 years, however, the increase in lift may increase the cost of pumping to the point where it will not be profitable.

In normal years, from 25 to 50 percent of the land capable of being irrigated by existing pumping plants is fallowed. During World War II the fallowed acreage was less than normal because of increased demand for foods and fibers.

The irrigation program is based on one pumping plant for each 1,000 acres in the ranch. Such a program is possible because of the included summer-fallow acreage and because the crops grown are chosen so that their irrigation requirements do not come at the same time. Winter crops, as barley and flax, are irrigated in November and December, and since they use relatively little water—1 to 1½ acre-feet—a large acreage can be irrigated by one pumping plant. Summer crops of cotton, grain sorghum, and vegetables require water in spring and summer only, and thus they can be grown without interfering with the irrigation of the winter crops. As spring and summer crops use more water, 2¼ to 4 acre-feet, the acreage that can be irrigated from one pumping plant is much less.

The average duty of water in the area, according to the local power company's computation, is 1.77 acre-feet an acre. A plant of average

[14] Based in part on an unpublished report for the Emergency Rubber Project on the water supply of the Coalinga area by Carl Rohwer and Harry F. Blaney, irrigation engineers, Division of Irrigation, Soil Conservation Service, U. S. Dept. Agr.

capacity (1,200 gallons pumped per minute) will pump 1,600 acre-feet in 300 days, and because it is required to supply water to only about 550 acres in any one year, is capable of delivering an average of 3 acre-feet of water per irrigated acre.

The quantity of water needed and the method of application depend to some extent on the kind of soil. Although clay soils normally have a relatively high water-holding capacity per unit mass of soil, a very shallow clay soil would have a low or very low available water-holding capacity because of the relatively small mass of soil available for roots. Soils with low capacity require frequent irrigation with small quantities of water, whereas those with high capacity can be irrigated infrequently with large quantities of water. Dry soils of high water-holding capacity require heavy applications of water to obtain adequate penetration of moisture.

The well water in the Coalinga area varies in quality. In general, the underground water of the recent alluvial formations is high in sulfates. Water from deep wells that penetrate marine deposits is highly impregnated with salt, mainly sodium chloride, and other constituents of ocean water. Water from the Tulare geological formation that lies between the surface alluvium and the marine deposits contains an excess of sodium in relation to the other bases. Boron in variable quantities is associated with the water from all sources. Some shallow wells draw water from the recent alluvium, but most of the irrigation water is obtained from deep wells in the Tulare formation.

Because the quantity and composition of salts in irrigation water have an important effect on soils and crops, water samples were collected and sent to the University of California for analysis and interpretation of results. These analyses and interpretations are given in table 7.

The analyses show that the concentration of chloride is relatively low in all samples and that the highest sulfate content occurs in water where the percentage of sodium is relatively low. Because of the variability in the quality of water, it is evident that before a recommendation for use of water from a particular well can be made, samples of water from the well should be analyzed.

According to information obtained from the local power company, the average cost of power for pumping an acre-foot of water in 1941 was $3.02. This is a weighted average and includes costs from all the plants in the Coalinga area. The unweighted average cost of power for pumping on 19 large ranches in the Coalinga area was $2.88 an acre-foot of water during the 1941–42 season. Costs per kilowatt-hour of electricity are low, the maximum being $0.0091 and the minimum $0.0049; the average is $0.0069. High costs in pumping operations occur where the load factor is low, or where the ratio of hours of operation to total hours is low; and low costs occur where the load factor is high. There is also a close correlation between total cost and lift of water. The average cost of power for lifting water is $0.0115 an acre-foot per foot of lift, which is exceptionally low; however, total costs of pumping may be relatively high because of high lifts.

The relative permeability of each soil of the Coalinga area is shown in the supplement to the soil map (cover page 3). Permeability

TABLE 7.—*Analyses* [1] *of water from wells in the Coalinga area, C*

[Analyses expressed in parts per million and milliequivalents per liter]

Location of wells sampled	K x 10^5 at 25° C.[2]	Boron as P. p. m.	HCO_3		Cl		SO_4		Ca		Mg
			P. p. m.	M. e.	P. p. m.	M. e.	P. p. m.	M. e.	P. p. m.	M. e.	P. p. m.
NW corner sec. 5, T. 21 S., R. 18 E	127.0	0.52	120	2.0	41	1.2	480	10.0	84	4.2	38
SW corner sec. 20, T. 19 S., R. 18 E	139.0	.92	160	2.6	65	1.8	492	10.3	65	3.2	47
SW corner sec. 18, T. 19 S., R. 18 E	153.0	1.56	190	3.1	110	3.1	472	9.8	61	3.0	49
Sec. 30, T. 20 S., R. 17 E	153.0	.64	205	3.4	55	1.6	576	12.0	105	5.2	64
NW corner sec. 36, T. 20 S., R. 18 E	130.0	.68	129	2.1	39	1.1	488	10.2	69	3.4	39
Sec. 20, T. 20 S., R. 17 E	153.0	.64	165	2.7	57	1.6	584	12.2	83	4.1	73
SE corner sec. 22, T. 18 S., R. 16 E	132.0	1.56	69	1.1	87	2.5	438	9.1	38	1.9	6
SW corner sec. 21, T. 17 S., R. 17 E	114.0	1.04	132	2.2	51	1.4	380	7.9	49	2.4	17
SW corner sec. 20, T. 17 S., R. 16 E	182.0	2.08	126	2.1	120	3.4	644	13.4	75	3.7	28
NW corner sec. 23, T. 18 S., R. 17 E	136.0	.01	109	1.8	73	2.1	488	10.2	57	2.8	27
SW corner sec. 26, T. 16 S., R. 15 E	150.1	2.00	135	2.2	50	1.4	590	12.3	70	3.5	29
SW¼ sec. 35, T. 16 S., R. 15 E	218.6	1.42	228	3.7	47	1.3	1,032	21.6	154	7.7	140
SW corner sec. 4, T. 17 S., R. 16 E	125.0	1.90	120	2.0	100	2.8	363	7.6	41	2.1	4
SW corner sec. 13, T. 16 S., R. 16 E	175.3	.88	179	2.9	57	1.6	734	15.3	125	6.3	95
Center south side, sec. 9, T. 16 S., R. 16 E	132.1	1.16	174	2.9	50	1.4	500	10.4	102	5.1	62
Center west side, sec. 32, T. 16 S., R. 16 E	116.1	1.50	126	2.1	46	1.3	404	8.4	52	2.6	15
SW.¼ sec. 5, T. 16 S., R. 17 E	110.0	1.37	90	1.5	83	2.4	291	6.1	34	1.7	5

[1] Reported by W. P. Kelley; analyses by J. C. Martin and J. B. Page, University of California. Water samples collected in November and December 1942.
[2] Specific conductance.
[3] Based on total milliequivalents of cations.
[4] W. P. Kelley interpreted the resul ity of the water for the growing of guay to be exacting, and it is reasonably sa normally grown in the Coalinga area.
[5] Probably satisfactory for a few ye

is measured in surface inches of water absorbed by a soil. A surface inch of water corresponds to water an inch deep over any given surface; it is the same measure as that used in measuring rainfall. A soil of moderate permeability in both surface and subsoil is for the most part ideal for irrigation. For soils of high permeability, irrigation basins should be small or field ditches short and the head of water relatively high; and for soils of low permeability, irrigation basins should be larger or field ditches longer and the head of water relatively low. Care should be taken not to overirrigate highly permeable soils or soils with surface layers of moderate or high permeability that overlie a subsoil of low or very low permeability.

EROSION

Erosion, a natural process removing soil and soil material, is affected by slope, soil, vegetation, climate, and land use. Erosion results in land building as well as land destruction. It may be beneficial in the accumulation and deposition of fertile material such as that making up the fertile alluvial fans and valleys, or it may be destructive in the removal of soil material more rapidly than it is formed through natural soil-forming processes. Erosion may be abnormally increased when man makes unwise use of sloping land by destroying or reducing a protective cover of natural vegetation through cultivation, overgrazing, or burning. This may reduce productivity or make the soil economically unsuited to use.

In the Coalinga area, eroded areas of soil types are separated on the map. The effects of soil erosion have been noted in the foregoing soil descriptions, and the more specific problems of erosion are discussed in the following pages. In general, the erosion problem in this area is very similar to that in the adjoining Mendota area [15] and Kings County (*6*).

Sheet erosion is the uniform washing of the soil from the surface of the land and is frequently accompanied by rilling, or the formation of small drainage channels. In cultivated fields, evidence of sheet erosion may be smoothed over and obliterated in the ordinary processes of cultivation, leaving little permanent indication of destructive erosion until the subsoil or other underlying material is exposed.

Gully erosion is the formation of drainage channels of such size and frequency that they interfere with tillage operations and, in severe cases, with the grazing of livestock. Gullies may vary in number, depth, form, and with character of the material into which they are cutting.

The slope of the land has a direct relation to the degree and character of erosion. The type of vegetative cover is also highly important in erosion control. The roots of plants in heavily vegetated areas hold the soil particles together; the vegetation forms a mat and reduces the impact and dispersing effect of rains and diminishes the velocity of water moving over the surface. Soils with good sod cover are well protected from erosion, but bare, overgrazed, or cleanly cultivated surfaces are not.

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[15] See footnote, 1, p. 3.

Since the Coalinga area does not cover extensive areas of sloping upland, the erosion problem in the area as a whole is less important than in other parts of the State. The Kettleman soils of the uplands in this area, however, are representative of a large area along the western edge of the San Joaquin Valley where erosion from intensive sheep grazing is a problem. Kettleman soils are especially erosive. They easily wash and their bedrock is relatively soft and in places is shattered, particularly along fault lines. These shattered areas are weak spots where gullies readily develop. Areas of severe sheet and gully erosion are also associated with certain angles of dip in the rocks. So much of the surface soil has been removed by sheet and gully erosion in many places on the Kettleman soils that their grazing value has been greatly reduced.

Erosion control in upland areas is difficult because of the close-grazing habits of sheep and the system of leasing and grazing. The sheep range is leased, usually by the year, at a fixed rental an acre to owners of roving bands. Under this system the range is grazed clean and the sheepmen have no permanent interest in the land. The present practice of turning the sheep in as soon as the first rains of fall or winter have started is detrimental to the grass because sheep graze closely and leave little opportunity for natural reseeding. Care should be taken in bedding down the sheep to prevent packing the soil and the total destruction of vegetation. Bedding grounds should be moved frequently and, wherever possible, to areas that are not likely to erode. In the past, upland tracts in this area have been good sheep range, and with care they can be restored. The county agricultural commissioner believes that deferring the time of grazing on the sheep range would be most effective in restoring pasture to its previous condition. This would allow the grasses to get a good start and have an opportunity to form seed before the sheep are turned in on the range.

Although the nearly level soils on alluvial fans are not subject to significant erosion from runoff caused by rainfall, they may present a problem under irrigation. Panoche and Panhill soils in particular are friable and easily gullied under careless irrigation. Adequate drops should be installed in irrigation ditches to reduce scouring and deepening to a minimum.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which that material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief or lay of the land; and (5) the length of time the forces of development have acted on the soil material. The influence of climate on soil and plants depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The Coalinga area lies on the west side of the San Joaquin Valley, a part of the large physiographic division known as the Great Interior Valley, or Central Valley, of California. Most of the land is tillable, but at the time of survey less than half of it was supplied with irrigation water and was cultivated.

The area is similar in many characteristics to the Mendota area to the north and to the western part of the Kings County survey, which adjoins it on the east and south. The climate is a macrothermal hot semidesert type, with an average annual rainfall of less than 8 inches that comes during mild winters followed by long hot dry summers. Mean rainfall and temperature are practically uniform over the entire area. The natural cover of short annual range grasses on the uplands and broad alluvial fans is usually sparse and dries up by late spring or early summer. Most of the rank growth of tules and swamp grasses that formerly covered the basin area has been removed by cultivation and replaced by a heterogeneous mixture of weeds and grasses.

A monotonously uniform relief of gently sloping and coalescing recent alluvial fans is characteristic of the western part of the area. The broad plain is bordered on the west near Pleasant Valley by short and relatively steeply sloping old fans lying at the base of low-lying foothills. This narrow rim of old alluvium along the base of the foothills is generally lacking in the northern part of the area. A west-to-east cross section taken near Pleasant Valley and another through the northern part of the area illustrate the relation of soils to topography. (See fig. 3.)

The Central Valley as a whole is a great structural trough, or basin, that once contained a large body of water. Alternate periods of uplifting and subsidence were accompanied by intervals of erosion and deposition, especially along the western border. Early deposits are generally considered to have been of marine origin and made during the early and middle Tertiary ages. During the later Tertiary and early Pleistocene periods, when the valley was supposedly outlined by the growth of the Coast Range, the marine deposits were covered by other deposits laid down in succeeding bodies of fresh water or by alluvial deposits distributed over the older deposits exposed by elevation. The present valley floor has been built up by recent Quarternary stream depositions on alluvial fans or in fluctuating lakes (Pleistocene lake sediments) dependent upon streams.

Under the arid conditions existing in this area, the composition of the parent rocks is probably the most important factor in the complicated process of soil genesis. In the main, the rocks of the western part of the Diablo Range, from which all except the basin soils have been derived, are a series of calcareous and gypsiferous sandstone, shale, and conglomerate of Cretaceous and earliest Tertiary (Eocene) age. A minor influence from the metamorphic rocks of the Franciscan or similar geologic formation (probably later Jurassic) is expressed by the browner color of a few soils adjacent to Los Gatos Creek. The low-lying hills surounding Pleasant Valley and the front row of hills along the western border of the area are classed as a series of Miocene and Pliocene marine sediments and are fringed by relatively coarse Quaternary and Upper Pliocene sediments. The

basin soils for the most part are composed of alluvium derived from rocks of the Sierra Nevada to the east of the valley. These rocks are mostly of granitic and metamorphic sedimentary and igneous materials of pre-Cretaceous age, overlain at the north and south ends of the valley by a series of Tertiary sediments of Miocene or Pliocene age (*5*).

The soils of the area are Pedocals developed under the general process of calcification (*3*). According to the soil association map of the United States (*10*), the well-drained well-developed soils of the area are included with Desert soils; however, intensive study may show that these soils developed under a very dry Mediterranean climate and may be sufficiently different from typical Desert soils or Red Desert soils to be included in a new soil group, such as a more alkaline counterpart of the noncalcic Brown soils group.

The zonal soils in this area are the soils developed on old alluvial fans; the azonal soils comprise those of the recent alluvial fans; and the intrazonal soils are the soils developed in place on underlying consolidated bedrock materials, soils of the valley basin rim, and soils of the valley basin. (See fig. 4.)

ZONAL SOILS

Most of the soils of the Coalinga area fit better in azonal or intrazonal groups than in the zonal group. Normal zonal soils of a region must have been in place long enough for the soil-forming processes to have fully expressed their influence. In order that these influences may be expressed, the relief must be gently undulating and not flat or hilly, there must be good but not excessive drainage, the parent material must not be of extreme texture or chemical composition, and there must be some natural erosion. Zonal soils in this area are those of the Lost Hills and Ortigalita series—soils developed on old alluvial fan materials.

SOILS DEVELOPED ON OLD ALLUVIAL FAN MATERIALS

The soils developed on old alluvial fan materials are of the Lost Hills and Ortigalita series. Normally they occupy relatively steep short older alluvial fans characterized by a hummocky microrelief. They are related in age, mode of formation, and geographic position. Both have noncalcareous surface soil and calcareous moderately compact subsoil. The main differences between the two series are probably the result of differences in parent material.

The Lost Hills soils—developed mainly from alluvium that originated in unaltered sedimentary rocks similar to those underlying the Kettleman soils—are pale brown or light yellowish brown and not so typical of the series as Lost Hills soils mapped in other surveys. They have an unusually deep and friable upper subsoil overlying the compact lower subsoil. This condition exists more consistently in the coarser textured than in the finer textured types.

The brown Ortigalita soil consists largely of outwash material (alluvium) derived from the Franciscan or a similar geologic formation. This formation consists of metamorphosed sedimentary rocks that may contain in places jasper, glaucophane schist, and several basic igneous intrusions, including serpentine.

LOST HILLS SERIES

The Lost Hills soils occupy older parts of well-drained alluvial fans that are piedmont to the eastern side of the Coast Range. The alluvial parent material originated mainly in upland areas of soft sedimentary rocks from which the Kettleman soils have developed, but the largest Lost Hills areas are located short distances from stream channels and are free from recent deposits. The soils have had sufficient time to form a well-defined subsoil.

The surface is nearly level or gently sloping and has a slight hummocky microrelief. Slopes range from 0 to 7 percent but on the average are less than 3 percent. Surface runoff is negligible to slight, depending largely upon the degree of slope. Alkali is found in only a few local spots. Vegetation consists of short annual grasses that begin their growth in winter and continue until the rainy season ends in April or May. During this season grazing is good, but the carrying capacity on an annual basis is only fair.

The surface soil is pale brown or light yellowish brown and generally noncalcareous. It is dominantly medium textured, breaks to a soft blocky structure, and is easily penetrated by roots, air, and water. At an average depth of about 10 inches there is an abrupt change to pale-brown or light yellowish-brown calcareous upper subsoil that is friable and deeper than normal for the series in other areas. At depths of 20 to 30 inches there is an abrupt transition to brown or pale-brown calcareous loam or clay loam that is moderately compact and has a well-defined prismatic structure. Lime is usually segregated into soft concretions or small blotches, and in places it lines the walls of small tubular pores.

The lower subsoil, in place and dry, has a system of vertical and horizontal cracks, and when disturbed, it breaks into small, firm, roughly cubical aggregates. It is light yellowish-brown calcareous loam, fine sandy loam, or light clay loam that generally contains some crystalline gypsum. Much colloidal staining is on the surfaces or cleavage planes of the aggregates. Parent material usually is encountered at depths below 40 or 50 inches and consists of light brownish-gray or light yellowish-brown calcareous generally stratified alluvial material. This material is normally coarser textured than the soil horizons above and is loose and friable.

ORTIGALITA SERIES

The Ortigalita soil occurs on old alluvial fan materials derived in part from hard metamorphosed sedimentary rocks of the higher Coast Range outside the area to the west. The soil has developed on high lying and relatively short alluvial fans that project from the bases of upland areas and is older in stage of development than the soils on the broad and gently sloping alluvial fans of the valley plains.

Normal relief is gently undulating (slopes, 2 to 7 percent) with a characteristic hummocky microrelief. Surface drainage is good but not excessive, and the soil on the steeper gradients is only very slightly eroded if at all. Vegetation consists mainly of short annual range grasses, some bur-clover and alfileria, and a scattering of low shrubs that supply fair pasture for sheep during years of favorable rainfall. Alkali is not present.

Representative profile of Ortigalita soil:

1. 0 to 17 inches, brown noncalcareous clay loam that is brittle when dry but plastic when wet and has weak blocky structure; may contain small quantities of small unevenly rounded gravel from mixed rocks; root and water penetration aided by numerous insect borings and small well-preserved root holes.
2. 17 to 24 inches, light yellowish-brown calcareous clay loam that is slightly compact and of indistinct blocky structure; lime segregated along tubular pores; may contain small gravelstones; root and water penetration only slightly retarded.
3. 24 to 39 inches, light yellowish-brown calcareous moderately compact clay loam of moderately well developed prismatic structure; contains an appreciable quantity of well-rounded gravel from mixed rock; root and water penetration somewhat retarded.
4. 39 to 50 inches, light yellowish-brown calcareous clay loam that is much less compact than layer above and without definite structure; contains lime-coated gravel; roots and water under natural conditions seldom penetrate into this horizon.
5. 50 to 60 inches, yellowish-brown calcareous gravelly loamy sand; stratified outwash materials from the Franciscan or similar geologic formation and other sedimentary rock sources.

AZONAL SOILS

Azonal soils show little or no profile development. Lack of development may be due to youth or to conditions of parent material or relief. In this area the azonal soils are those of Panoche, Panhill, and Sorrento series. They occupy recent alluvial fans.

SOILS OF THE RECENT ALLUVIAL FANS

The soils of the recent alluvial fans—the Panhill, Panoche, and Sorrento—are closely related in mode of formation and parent material, but they each have individual characteristics of color, profile development, and geographic position.

The Panhill series consists of soils that occupy slightly older fans and that have reached a stage in development between the recent Panoche soils and the moderately developed Lost Hills soils. Panhill surface soils are light brownish gray, noncalcareous, and friable. The lower subsoil is characterized by a definite zone of lime accumulation and is believed to indicate a slight advancement in stage of development over the recent Panoche soils. There is considerable evidence that a close genetic relationship exists among the Panoche, Panhill, and Lost Hills series, the soils differing primarily in age.

Sorrento soils in this area are not so typical of the series as those mapped in other areas where the rainfall is slightly higher. They occur in a few bodies adjacent to Los Gatos Creek in this survey and show some influence of material from the Franciscan or a similar geologic formation.

PANHILL SERIES

Panhill soils occur on alluvium derived from softly consolidated calcareous and gypsiferous sedimentary rocks of the lower foothills lying to the west of the area. They normally occupy slightly older alluvial fans between the hills and the valley trough and are characterized by a very gently sloping slightly hummocky surface. Erosion is slight because these soils readily absorb the low annual rainfall and the runoff from the uplands. Most of the soils are free of alkali,

but there are a few areas with slight concentrations. Natural vegetation consists of a wide variety of short annual range grasses mixed with a scattering of desert shrubs.

These soils have a light brownish-gray or light yellowish-brown medium- or light-textured surface soil that is friable and noncalcareous or very slightly calcareous. If the soil is disturbed when thoroughly dry, it breaks into firm roughly cubical aggregates. Medium-textured types are dominant within the series, and they are porous, friable, and easily penetrated by roots and water.

The upper subsoil, beginning at a depth of about 16 or 20 inches and varying in thickness from 10 to 14 inches, is clearly defined from the surface soil by accumulations of lime carbonate and by a pale-brown or yellowish-brown color. The underlying material, to depths in excess of 40 inches, is moderately calcareous, generally coarser textured than the layers above, and pale brown or light yellowish brown. At this depth there may be stratifications of silty material or occasional thin sand layers, and small quantities of crystalline gypsum.

PANOCHE SERIES

Panoche soils consist of recently deposited alluvium originating principally in the softly consolidated calcareous and gypsiferous sandstone and shale lying on the eastern slopes of the Coast Range. In general, the soils are very gently sloping and have smooth surfaces, but they are slightly hummocky in a few places. Erosion is negligible, but a few large areas south and west of Huron and in the vicinity of Cantua Creek periodically receive small deposits from floodwaters.

The soils are permeable, and rainfall and runoff waters are usually rapidly absorbed. Under irrigation, however, the soils are apt to gully severely if irrigation water is not carefully applied. Most of these soils are free of alkali or only slightly affected, but a few small areas contain moderate quantities of salts. The natural vegetation consists principally of short annual grasses that normally afford fair pasture for sheep in spring and early summer.

Representative profile of Panoche soil:

1. 0 to 18 inches, light brownish-gray friable and slightly calcareous loam that is porous and low in organic matter; generally contains a few thin silty strata that do not materially affect root and water penetration; weak blocky structure; normally this is the zone of root concentration for the shallow-rooted natural vegetation and for crops.
2. 18 to 40 inches, loose permeable light brownish-gray fine sandy loam that is more calcareous than the surface soil; very low in organic matter; may contain some silty strata.
3. 40 to 60 inches, light yellowish-brown fine sandy loam that is only slightly calcareous and in few places contains small specks of gypsum; strata of coarse material may occur at depths in excess of 50 inches; friable and permeable.

SORRENTO SERIES

The Sorrento soils occur on recent alluvial materials washed principally from areas of rather hard and in some places metamorphosed sedimentary rocks. Typically, they have a smooth nearly level relief, but in this area they are somewhat more sloping and have a slightly hummocky microrelief. The natural vegetation consists of short

annual grasses that normally afford fair pasture for sheep. Erosion is slight or negligible because these soils readily absorb the low annual rainfall of the region. Alkali is not present.

In the Coalinga area these soils have a brown, pale-brown, or yellowish-brown noncalcareous friable surface soil that is dominantly of medium texture. This layer has a tendency to bake and to break into slightly hard nutlike aggregates if disturbed when dry and is somewhat browner and plastic or sticky when wet. It is deep and easily penetrated by roots and water. The upper subsoil, beginning at an average depth of 16 or 22 inches, is yellowish brown, very slightly compact, and intermittently calcareous. This layer is not so pronounced as in Sorrento soils of other surveys. Below 40 or 50 inches, the lower subsoil, extending to considerable depths, is calcareous, friable, and generally stratified with sandy or silty alluvial material. It is usually light brown or light yellowish brown and coarser textured than the surface soil and upper layers.

INTRAZONAL SOILS

Intrazonal soils may have moderately well developed profiles, but one or more local factors, such as poor drainage, parent material, and high salt content, dominate the forces tending to develop the zonal characteristics of the region. This group is made up of soils of the Kettleman, Linne, Lethent, Levis, Oxalis, Merced, and Temple series. The Kettleman and Linne soils developed in place on underlying consolidated bedrock materials; the Lethent, Levis, and Oxalis, on the valley basin rim; and the Merced and Temple, in the valley basin.

SOILS DEVELOPED IN PLACE ON UNDERLYING CONSOLIDATED BEDROCK MATERIALS

The Kettleman and Linne soils have developed in place on underlying consolidated bedrock materials. Kettleman soils are primarily upland soils derived from calcareous and gypsiferous sandstone and shale of the upper Cretaceous marine sediments. They have been classified as Rendzinas (*10*) and appear to have too high a lime content to meet the requirements of zonal soils. They are light brownish-gray calcareous soils and are the dominant upland soils along the western edge of the southern San Joaquin Valley. A few miles farther west at higher elevations there is an increase in rainfall, and soils with pedalferic characteristics are more evident. Kettleman clay loam of the Ciervo Hills region north of Cantua Creek is derived mainly from argilliferous sandstone rather than shale.

Kettleman soils belong to a fairly well established sequence of calcareous soils that occur extensively in the Diablo Range and differ mainly in color. Starting with the very dark-gray or nearly black Zaca soils, there are dark-gray Linne soils, grayish-brown Nacimiento soils, gray Shedd soils, and light brownish-gray Kettleman soils. Climate is the main factor that has brought about these color differences, but parent material differences in places are also important.

The Kettleman-Linne complex of soils mapped in this area near Domengine Creek is the result of weathering and erosion of tilted and shattered blocks of soft fine-grained shale and is a good example of the influence parent material has on soil color. The tilted shale

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in places is darker than most of the other shale in the area and has weathered in ravines and on north slopes where moisture conditions are somewhat higher. The combination of dark shale and more effective moisture has resulted in the dark-gray fine-textured Linne soil, which is of relatively good depth. Smaller blocks of sandstone and lighter colored shale interbedded with the dark shale formation give rise to the light brownish-gray medium-textured relatively shallow Kettleman soils.

KETTLEMAN SERIES

The Kettleman soils have formed in place from underlying softly consolidated sedimentary rocks and have weakly to slightly developed profiles. They are the dominant upland soils in the foothill section along the western boundary of the survey. They have hilly relief. Normal slopes range from 15 to 30 percent, but large areas having gentler or steeper slopes also occur. Erosion is in many places moderate and in some places severe. The soils are soft, move readily when saturated, and are easily gullied by a relatively small amount of runoff.

In a few places small quantities of soluble salts are present in the parent material, and in these occur areas slightly spotted with alkali. Slick spots at the base of steeper slopes are indicative of alkali and are generally badly eroded. The natural vegetation consists mainly of short annual grasses and low brush, the amount of growth depending largely upon seasonal rainfall. The grasses begin growth in December and continue until May, when the rainy season normally ends. These soils are not cultivated and are used almost entirely as range pasture for sheep.

Representative profile of Kettleman soil:

1. 0 to 8 inches, light brownish-gray calcareous friable loam of weak granular structure; readily absorbs moisture; low organic-matter content; supports a relatively scant cover of grasses.
2. 8 to 18 inches, light brownish-gray, shading towards light yellowish brown, calcareous friable loam of weak blocky structure; readily crumbles under pressure; very slightly compact; contains small quantities of crystalline gypsum.
3. 18 to 40 inches +, light yellowish-brown softly consolidated gypsiferous and calcareous sandstone; contains white seams of lime carbonate; generally partly disintegrated.

SOILS OF THE VALLEY BASIN RIM

The soils of the valley basin rim—the Lethent, Levis, and Oxalis—occur on the outer edges or lower part of alluvial fans on which Panoche soils occur at higher elevations. They normally contain moderate or strong accumulations of soluble salts, are calcareous and gypsiferous, and fall in the halomorphic group of intrazonal soils. They differ in stage of profile development, color, and drainage. They have not developed under conditions of a naturally high water table, and their salty or alkali character probably developed over a period of time from recurrent brief flooding by moderately saline waters.

Lethent soils apparently are older than Levis or Oxalis soils and have moderately compact subsoil. Lethent soils are similar in stage of development and other characteristics to Lost Hills soils but are moderately or strongly affected by salts. The Levis soil is similar

in a number of respects to Panoche soils but differs in having a high content of salt that results in a distinctly fluffy surface soil. Oxalis soils are associated with slightly higher lying Panoche soils but are somewhat darker and normally contain more salts and gypsum in the subsoil.

LETHENT SERIES

The Lethent soils occur on alluvium derived mainly from fine-grained sandstone and shale rocks that are high in lime and gypsum. In this area they occupy basin-rim positions where surface drainage is slow. There is little runoff, for the soils absorb most of the rain that falls, and the slope is usually less than 1 percent. The soils are normally high in alkali and are capable of supporting a cover of only halophytic plants, such as saltgrass and a scattering of alkali-tolerant Atriplex shrubs. In a few places vegetation is completely lacking. Where alkali concentrations are not particularly strong, however, short annual grasses grow.

Representative profile of Lethent soil:

1. 0 to 8 inches, light brownish-gray slightly calcareous silty clay that is brittle when dry and sticky when wet; weak blocky structure.
2. 8 to 17 inches, yellowish-brown calcareous silty clay that is moderately compact and of moderately well developed prismatic and blocky structure; slight amount of lime segregation.
3. 17 to 35 inches, yellowish-brown slightly calcareous silty clay; less compact and of less distinct structure than layer above.
4. 35 to 55 inches, light yellowish-brown slightly calcareous silty clay containing considerable gypsum and soluble salts; rather massive.
5. 55 to 72 inches, yellowish-brown slightly calcareous light silty clay loam containing some gypsum and soluble salts but much less than layer above; rather massive.

LEVIS SERIES

The Levis soil is composed mainly of fine-textured alluvium derived from sandstone and shale rock formations fairly high in content of lime carbonate and gypsum. This soil is probably a little older than the Panoche soils of the recent fans and occupies the outer and more slowly drained parts of the fans toward the basin areas. It contains strong alkali concentrations, consisting almost entirely of neutral salts, or white alkali. Average slopes are nearly level (1 percent or less), but the surface is slightly hummocky in most places. These low hummocks have been formed largely by heaving of the soil. The soil heaves because of its characteristically high salt content. Erosion or deposition is negligible. The low annual rainfall is readily absorbed, and there is practically no surface movement of water. A scant native vegetation consists entirely of alkali-tolerant weeds, low brush, and Atriplex shrubs.

The Levis soil has light brownish-gray or light yellowish-brown intermittently calcareous surface soil that is fine textured and consistently high in alkali. This surface layer is friable and porous and forms soft clods when disturbed. Many well-preserved root holes and insect casts permeate this layer when dry, but when moist the soil runs together and becomes very sticky. There is a gradual change to a grayish-brown or yellowish-brown upper subsoil that has a weak prismatic structure when dry. The upper subsoil begins at an average depth of 10 inches and ranges from 10 to 15 inches thick. High

concentrations of lime, gypsum, and salts are normally present. The lower subsoil is light brownish gray or light yellowish brown and usually contains higher concentrations of segregated lime, gypsum, and soluble salts than layers above. Although the entire profile is uniformly fine textured, the high salt content gives rise to a flocculated condition of the clay, and the soil in places is fluffy and soft. When thoroughly dried in summer, a typical dry-bog condition exists in many places.

OXALIS SERIES

The Oxalis soils occur on alluvial deposits derived principally from softly consolidated calcareous and gypsiferous sandstone and shale of the Diablo Range lying to the west of the area. They are in a youthful stage of development and occur on the outer parts of gently sloping fans where surface drainage is slow. No appreciable extent of deposition or erosion is taking place on the soils. Most of the soils are affected by concentrations of alkali ranging from slight to moderate. The native vegetation was largely a dense growth of grasses.

The surface soil to an average depth of about 14 inches is fine textured, calcareous, and grayish brown; it becomes dark grayish brown when moist. It is very sticky when wet but friable and penetrable to roots when moist. When disturbed it forms small clods that are easily worked to a seedbed. This surface soil, on drying after irrigation, cracks and checks deeply, producing blocks 8 to 12 inches square and forming an adobelike structure. These blocks in turn develop a system of secondary cracks on further drying. Moderate quantities of disseminated lime are normally present in the surface soil, but in areas transitional to Lethent soils the lime content may be low. The surface soil puddles readily, but water penetration is normally good because the fine soil particles tend to be flocculated and because there are many root holes and insect borings.

There is a gradual transition from the surface soil to the grayish-brown or yellowish-brown upper subsoil, which averages about 18 inches thick and contains moderate to large quantities of lime and gypsum. The upper subsoil is normally fine textured, and hard or plastic depending upon moisture conditions.

There is another gradation into a lower fine-textured subsoil that is pale brown or yellowish brown, highly calcareous, and gypsiferous. This layer often contains stratifications of fine silty material, and in places where the downward movement of water has been restricted by these stratifications, a temporary water table is created that causes a slight degree of rust-brown mottling in the soil mass. Irrigation water penetrates to the lower subsoil, but roots of shallow-rooted crops and grass rarely reach this far into the profile. Alkali accumulations are generally more concentrated in the subsoil than in the surface soil.

SOILS OF THE VALLEY BASIN

The dark Merced and Temple soils of the valley basin have developed under poor drainage conditions and from the alluvial material that originated partly in areas of granitic rock.

Merced soils are derived from mixed sediments laid down in partly enclosed basin areas, but they are fine textured throughout, with well-developed subsoil. An improvement in drainage conditions alone would only slightly improve them. This series is the dominant basin series in the area and is consistent with the series as mapped in other surveys.

Temple soils are derived from alluvium deposited in depressions or basinlike areas near main drainage channels where poor drainage prevails a greater part of the year. A rank growth of tule and water grass under natural conditions is responsible for their dark color and relatively high organic-matter content. Establishment of improved drainage in the basin area will probably initiate a new soil-forming cycle for these and other dark soils of the basin. The first evidence will be a decrease of organic-matter content and a resultant lighter gray surface color. If the water table is lowered sufficiently for a long period of time, the gray mottling of the subsoil will be replaced by a browner color. A more friable subsoil possibly will evolve as root penetration into the subsoil increases.

MERCED SERIES

The Merced soils have developed on alluvium derived from mixed granitic and sedimentary rocks and deposited in flat poorly drained parts of the valley basin. Surface drainage is slow because slopes are nearly level. Internal drainage is restricted by a moderately developed subsoil. Alkali content is slight, or absent, and confined generally to the subsoil. The native vegetation consisted mainly of tules and swamp and salt grasses, most of which has been replaced by weeds and grasses that gained a foothold where the original cover was grazed off or destroyed by cultivation.

Profile description of Merced soil:

1. 0 to 10 inches, gritty, micaceous, dark-gray noncalcareous clay that cracks into large blocks when dry but runs together and becomes sticky when wet; nearly neutral in reaction; moderate organic-matter content.
2. 10 to 24 inches, dark-gray mottled intermittently calcareous clay of moderately compact and moderately well developed blocky structure; moderate organic-matter content.
3. 24 to 38 inches, gray, with rust-brown mottling, clay of distinct prismatic structure; structural units visibly stained with mineral and organic materials; lime concentrated in the form of small specks and soft concentrations; may contain crystalline gypsum in places; root and water penetration definitely retarded.
4. 38 to 62 inches, olive-gray calcareous clay that is mottled from a recurrent high water table; soil massive in place but breaks into small irregularly shaped blocks that generally contain coarse micaceous grit.
5. 62 to 72 inches, olive-gray calcareous heavy sandy loam that is highly micaceous and contains a variable quantity of nodular lime; generally mottled from a recurrent high water table and similar to the substrata underlying most of the dark basin soils of the area.

TEMPLE SERIES

The Temple soils are derived from mixed granitic and sedimentary rock alluvium that has been deposited by slowly moving floodwaters from Fresno Slough in flat basinlike areas adjacent to the main drain-

age channels of the valley trough. They are youthful in profile characteristics and somewhat similar to and at about the same stage of development as soils of the Sacramento series mapped extensively in the Sacramento Valley. Both in the surface and subsoil drainage is slow, but no significant concentration of alkali occurs in the Temple soils of this area. The native vegetation consisted of tule and swamp grasses, but there is little of this cover left, for most of the Temple soils are cultivated.

The surface soil consists of dark-gray or dark grayish-brown friable noncalcareous normally fine-textured material that is relatively high in organic matter. It is nearly neutral in reaction and easily penetrated by roots and water. A soft cloddy structure forms when the dry soil is disturbed, but when moist the soil becomes very sticky. The upper subsoil, beginning at an average depth of 10 inches, is gray or dark-gray friable fine-textured material, intermittently calcareous and moderately high in organic matter. Below a depth of about 24 inches, this layer grades into the lower subsoil, which is grayish brown, highly calcareous, slightly compact, and generally of medium to fine texture. There is a noticeable gray mottling of the lower subsoil, and the soft aggregates are stained with mineral and organic colloids. The mottling becomes less pronounced as highly calcareous olive-gray sandy clay loam or sandy loam substrata are reached at an average depth of 50 inches. This lower material appears to have been under water for a longer time than the soil material above.

LABORATORY STUDIES [16]

All soil samples for laboratory analyses were screened through a 2-millimeter sieve. Soil aggregates were crushed with a rubber-tipped pestle, and gravel and stones larger than 2 millimeters were rubbed relatively clean. The sieved material was thoroughly mixed, and aliquot parts were used for the laboratory analysis. A mechanical analysis was made of each surface soil sample by a proximate method. These results were used mainly to check the field textural classification of surface soils and are not given in this report.

Several soil profiles were chosen for a more complete study. Mechanical analyses of samples from these profiles were made by the modified International method, in which a weighed sample of sieved soil is pretreated with hydrogen peroxide and hydrochloric acid to remove, respectively, organic matter and carbonates. After washing free of electrolytes, dispersal was effected by shaking overnight in distilled water to which sodium oxalate had been added. The sands were separated from the silt and clay by wet-sieving through a 300-mesh sieve and then dried and weighed to determine the total quantity of sands. The suspension of silt and clay was sampled by means of a pipette at time intervals to give effective maximum diameters of coarse silt at 50 microns, of fine silt at 5 microns, or clay at 2 microns, and of colloidal clay at 1 micron. The results of these analyses are given in table 8.

[16] This section, with the exception of color determinations, contributed by E. P. Perry, Division of Soils, University of California Agricultural Experiment Station.

TABLE 8.—*Mechanical analyses of eight soils of the Coalinga area, Calif.*

[Percentages are reported as separately determined; since there is minor experimental error involved in any analysis, these percentages deviate from a total of 100]

Soil type and sample No.	Depth	Total sand [1] (2.00–0.05 mm.)	Coarse silt (50–5μ)	Fine silt (5–2μ)	Clay (<2μ)	Colloidal clay (<1μ)
Lethent silty clay:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
5710410	0–8	6. 9	28. 8	17. 2	46. 5	33. 8
5710411	8–17	5. 4	32. 7	19. 9	41. 7	27. 1
5710412	17–35	3. 1	23. 6	18. 3	55. 8	43. 7
5710413	35–55	5. 9	16. 4	23. 5	53. 8	44. 3
5710414	55–72	12. 6	29. 6	17. 1	40. 1	30. 3
Temple silty clay:						
5710415	0–11	19. 1	25. 1	15. 1	41. 1	29. 4
5710416	11–18	15. 2	31. 9	15. 8	37. 1	26. 2
5710417	18–34	32. 8	28. 7	7. 3	31. 3	26. 9
5710418	34–49	51. 2	29. 4	4. 2	15. 6	12. 9
5710419	49–60	34. 5	25. 0	8. 8	30. 7	25. 3
Merced clay (adobe):						
5710420	0–10	3. 1	19. 4	12. 7	64. 9	55. 8
5710421	10–24	3. 2	19. 7	14. 8	62. 1	49. 8
5710422	24–38	3. 6	14. 9	14. 5	66. 9	55. 3
5710423	38–62	13. 3	17. 1	16. 0	55. 2	44. 1
5710424	62–72	59. 0	15. 5	3. 9	20. 5	17. 4
Panoche clay loam:						
5710429	0–21	18. 0	36. 9	14. 5	31. 0	23. 4
5710430	21–48	5. 3	28. 0	20. 1	46. 4	34. 6
5710431	48–60	25. 7	31. 5	12. 5	31. 2	23. 6
Oxalis silty clay:						
5710432	0–18	19. 2	29. 0	15. 5	34. 9	21. 9
5710433	18–33	15. 3	24. 2	14. 4	47. 0	37. 0
5710434	33–41	23. 7	28. 6	13. 0	35. 6	25. 9
5710435	41–60	25. 1	39. 9	10. 1	24. 7	18. 1
Kettleman loam:						
5710439	0–8	58. 1	21. 1	4. 6	16. 4	12. 8
5710440	8–18	57. 9	18. 3	6. 0	18. 8	15. 9
5710441	18–40	(2)	------	------	------	------
Ortigalita clay loam:						
5710450	0–17	40. 6	18. 2	6. 6	35. 6	31. 9
5710451	17–24	48. 2	23. 8	5. 3	21. 2	16. 6
5710452	24–39	68. 3	23. 9	2. 7	4. 7	3. 1
5710453	39–50	51. 5	32. 0	6. 1	9. 5	5. 4
Lost Hills loam:						
5710458	0–9	64. 4	12. 6	2. 8	19. 1	15. 9
5710459	9–20	64. 6	12. 4	3. 0	18. 9	15. 7
5710460	20–28	68. 1	11. 6	1. 7	18. 7	16. 5
5710461	28–48	59. 5	6. 2	1. 4	32. 5	29. 9
5710462	48–56	74. 4	9. 3	1. 0	15. 0	13. 6
5710463	56–72	84. 9	5. 9	1. 1	7. 8	6. 7

[1] Sand separates of fine gravel, coarse sand, medium sand, fine sand, and very fine sand were not determined.
[2] Sandstone.

Moisture equivalents were determined by the standard method, in which 30 grams of saturated soil was subjected to a force of 1,000 times gravity in a centrifuge for 30 minutes. Results are reported in table 9 as the percentage of moisture retained by the soil sample, as calculated on the basis of oven-dry soil. A few soils are so impermeable that water is not thrown out by centrifugal force and remains on the surface of the soil. For such soils the moisture equivalent is repeated in the usual moisture-equivalent cups, but paraffined paper linings are added to the sides of the cups to allow this excess water to drain away. Footnotes to table 9 indicate soils in the area for which paraffined paper linings were added in making analyses. Where drainage is satisfactory, the moisture equivalent in table 9 represents approximately the normal field-moisture capacity, or the quantity of water held in a soil after a heavy rain or an irrigation where downward drainage is free and uninterrupted.

TABLE 9.—*pH, carbonates, moisture equivalents, and color of soils in the Coalinga area, Calif.*

Soil type and sample No.	Depth	pH [1]	Calcium carbonate [2]	Moisture equivalent	Color [3]	
					Dry soil	Moist soil
Panhill fine sandy loam:	*Inches*		*Percent*	*Percent*		
5710401	0–26	7. 1	-----	9. 6	2Y5. 5/3. 0	2Y4. 0/3. 0
5710402	26–48	8. 1	1. 8	15. 6	2Y6. 0/2. 5	2Y5. 0/3. 0
5710403	48–65	8. 4	3. 0	15. 9	2Y6. 0/2. 5	2Y5. 0/3. 0
5710404	65–72	8. 3	. 8	10. 1	2Y5. 5/2. 5	2Y4. 0/2. 5
Lost Hills fine sandy loam:						
5710405	0–10	7. 8	. 5	12. 9	2Y5. 5/3. 0	2Y4. 5/2. 5
5710406	10–21	8. 0	1. 5	12. 6	[4] 2Y5. 5/3. 0	2Y4. 5/2. 5
5710407	21–42	8. 4	5. 7	14. 5	2Y6. 0/2. 5	2Y5. 0/3. 0
5710408	42–58	8. 3	2. 9	9. 7	2Y5. 5/3. 0	2Y4. 5/3. 0
5710409	58–72	8. 2	2. 4	10. 9	2Y5. 5/3. 0	2Y4. 5/3. 0
Lethent silty clay:						
5710410	0– 8	7. 9	. 5	30. 2	2Y6. 0/2. 5	2Y4. 0/2. 0
5710411	8–17	8. 1	2. 7	31. 7	2Y5. 0/3. 0	2Y4. 5/2. 5
5710412	17–35	8. 1	2. 2	[5] 43. 1	2Y5. 0/3. 0	2Y4. 5/2. 5
5710413	35–55	7. 9	2. 5	[5] 48. 3	2Y6. 0/3. 0	2Y4. 5/3. 0
5710414	55–72	7. 9	2. 2	[5] 35. 2	2Y5. 5/3. 0	2Y4. 5/2. 5
Temple silty clay:						
5710415	0–11	6. 5	-----	50. 6	2Y5. 0/1. 0	2Y2. 5/1. 0
5710416	11–18	7. 2	. 5	51. 5	2Y5. 5/1. 0	2Y3. 0/1. 0
5710417	18–34	7. 4	. 8	31. 5	[6] 2Y5. 0/1. 5	3Y3. 5/1. 5
5710418	34–49	8. 1	4. 4	22. 2	5Y6. 0/1. 5	5Y4. 5/2. 0
5710419	49–60	8. 0	2. 0	25. 6	[6] 5Y5. 0/2. 0	5Y4. 5/2. 0
Merced clay (adobe):						
5710420	0–10	6. 6	-----	43. 5	2Y4. 0/0. 5	2Y3. 0/0. 5
5710421	10–24	6. 8	-----	44. 0	2Y4. 0/0. 5	2Y3. 0/1. 0
5710422	24–38	7. 7	4. 4	35. 5	[7] 5Y4. 5/1. 0	5Y4. 0/1. 5
5710423	38–62	7. 9	6. 8	37. 3	[7] 5Y5. 5/2. 0	5Y5. 0/2. 0
5710424	62–72	8. 0	4. 3	20. 7	5Y5. 5/2. 5	5Y4. 0/2. 0
Levis silty clay:						
5710425	0– 9	8. 2	3. 5	30. 3	3Y5. 5/2. 0	3Y4. 5/2. 5
5710426	9–20	7. 9	5. 7	[5] 36. 4	3Y5. 0/2. 0	3Y4. 5/2. 5
5710427	20–42	7. 7	4. 4	31. 9	3Y5. 5/2. 0	3Y4. 0/2. 0
5710428	42–60	7. 7	4. 4	[5] 28. 4	2Y5. 5/3. 0	2Y4. 5/2. 5

See footnotes at end of table.

TABLE 9.—*pH, carbonates, moisture equivalents, and color of soils in the Coalinga area, Calif.*—Continued

Soil type and sample No.	Depth	pH [1]	Calcium carbonate [2]	Moisture equivalent	Color [3]	
					Dry soil	Moist soil
			Percent	*Percent*		
Panoche clay loam:	*Inches*					
5710429	0–21	8. 0	3. 5	32. 5	2Y6. 0/2. 5	2Y4. 5/3. 5
5710430	21–48	8. 1	1. 8	38. 0	2Y6. 0/2. 5	2Y4. 5/3. 5
5710431	48–60	7. 8	3. 6	29. 3	2Y6. 0/3. 0	2Y4. 5/3. 5
Oxalis silty clay:						
5710432	0–18	8. 4	4. 6	29. 9	2Y5. 0/2. 5	2Y4. 5/3. 0
5710433	18–33	8. 2	2. 6	[5] 35. 7	3Y4. 5/3. 0	3Y4. 0/2. 5
5710434	33–41	8. 0	2. 9	28. 8	3Y4. 5/3. 0	3Y4. 0/2. 5
5710435	41–60	7. 8	2. 2	25. 9	3Y5. 0/3. 0	3Y4. 5/3. 0
Panoche fine sandy loam:						
5710436	0–20	7. 9	2. 0	9. 8	2Y5. 5/3. 0	3Y4. 0/3. 0
5710437	20–47	8. 1	2. 9	9. 5	2Y5. 5/3. 0	3Y4. 0/3. 0
5710438	47–72	7. 9	2. 2	23. 9	2Y5. 0/3. 5	3Y4. 0/3. 5
Kettleman loam:						
5710439	0–8	7. 8	5. 5	19. 0	1Y6. 0/2. 5	1Y4. 5/2. 5
5710440	8–18	7. 8	11. 2	21. 4	1Y6. 0/3. 0	1Y5. 0/3. 0
5710441	18–40	([8])	-----	------	[9] 2Y7. 0/3. 0	2Y6. 0/3. 0
Panhill clay loam:						
5710446	0–16	7. 8	1. 7	20. 0	1Y5. 5/3. 0	1Y4. 5/2. 5
5710447	16–29	8. 0	7. 5	21. 4	[4] 2Y6. 0/3. 0	2Y5. 0/3. 5
5710448	29–38	8. 2	8. 8	24. 1	[4] 2Y6. 0/3. 0	2Y5. 0/3. 5
5710449	38–60	8. 3	4. 9	19. 6	2Y6. 0/3. 0	2Y5. 0/3. 0
Ortigalita clay loam:						
5710450	0–17	7. 3	1. 8	26. 0	10YR5. 0/3. 0	10YR4. 0/3. 0
5710451	17–24	8. 4	7. 1	25. 0	[4] 2Y6. 0/3. 0	2Y4. 5/3. 5
5710452	24–39	8. 5	5. 5	20. 7	2Y6. 0/3. 0	2Y4. 5/3. 5
5710453	39–50	8. 3	7. 8	18. 4	2Y6. 0/3. 0	2Y4. 5/3. 5
5710454	50–60	8. 2	9. 8	19. 6	2Y5. 5/3. 0	2Y4. 5/3. 0
Sorrento fine sandy loam:						
5710455	0–22	7. 4	1. 1	10. 1	10YR5. 0/4. 0	10YR4. 0/3. 5
5710456	22–48	7. 6	1. 2	10. 0	10YR5. 5/4. 0	10YR4. 0/3. 5
5710457	48–72	8. 0	1. 6	10. 1	1Y5. 5/4. 0	1Y4. 0/4. 0
Lost Hills loam:						
5710458	0–9	7. 5	1. 1	17. 3	2Y5. 5/2. 5	2Y4. 0/2. 0
5710459	9–20	7. 8	1. 6	16. 3	1Y5. 5/3. 0	1Y4. 5/2. 5
5710460	20–28	8. 0	1. 6	14. 9	1Y5. 5/3. 0	1Y4. 5/2. 5
5710461	28–48	8. 2	2. 8	23. 1	[4] 10YR5.0/3.0	10YR5. 0/4. 0
5710462	48–56	8. 1	1. 5	13. 9	2Y6. 0/3. 0	2Y5. 0/3. 0
5710463	56–72	8. 1	2. 0	9. 3	1Y5. 5/2. 5	1Y5. 0/2. 5

[1] By Beckman pH meter.
[2] By McMiller method.
[3] By Munsell notation determined by visual comparison under natural daylight with Munsell color standards.
[4] Contains segregations of white lime.
[5] Water on soil surface after first centrifuging; percentage given is result of second moisture-equivalent determination in which waxed paper was used to line sides of the cups.
[6] Mottled with yellowish brown.
[7] Mottled with strong brown.
[8] Sandstone.
[9] Contains coatings of white lime.

Determinations of pH (see table 9) were made by the Beckman pH meter. Fifty grams of air-dry soil were put into a tall 4-ounce bottle, and enough distilled water was added to saturate the soil. The readings given in table 9 were made after allowing the wet soil to stand a few hours. The pH values are predominantly basic and reflect the aridity of the climate and the influence of the calcareous parent material. The surface samples of Temple silty clay and Merced clay (adobe), soils derived from noncalcareous material and relatively high in organic matter, are slightly acid in reaction. The subsoils are calcareous and basic, however. The profiles of Levis silty clay and Oxalis silty clay show increased pH values in the surface soils. This is probably due to evaporation from the surface, which leaves an accumulation of salts. All other profiles are basic throughout and increase in pH value with depth.

As listed in table 9, carbonates were determined for all soils with a pH above 7.0 These determinations were made by the McMiller method, whereby the soil is treated with standard hydrochloric acid until effervescence ceases and the mixture then titrated with a standard base to determine the quantity of acid used in the reaction. The acid used is assumed to be equivalent to the quantity of calcium carbonate. It is recognized that this method involves certain errors, particularly when sodium carbonate is present, for the total carbonate is calculated as calcium carbonate, or lime.

The soils of all but three series sampled contain varying quantities of calcium carbonate. The upper layers of Temple silty clay, Merced clay (adobe), and Panhill fine sandy loam did not contain calcium carbonate. The Temple and Merced soils are the only two soils in the area derived mainly from granitic alluvium transported from the Sierras on the east side of the San Joaquin Valley. All of the other soils have formed from west-side alluvium transported from calcareous soils on the eastern slopes of the Coast Range foothills. The surface soils of the fine-textured Panhill types and of the Lethent series may contain small quantities of lime, which in most instances are not detected in the field with weak hydrochloric acid. In most of the profiles there is an accumulation of lime in the subsoil, for the low rainfall is not sufficient to dissolve it and carry it out of the profile.

The moisture-equivalent values, as shown in table 9, range from 9.3 percent in the lower part of the Lost Hills loam profile to 51.5 percent in the profile of Temple silty clay. This high value for the Temple silty clay is undoubtedly due to its high organic-matter content. The Lethent, Levis, and Oxalis soils contain salt and tend to have slowly permeable subsoils, as evidenced by water standing on the surface of the soils after centrifuging. With waxed paper sides inserted into the cups, drainage is facilitated and the quantity of water retained after centrifuging probably is close to the normal field-moisture capacity.

The color of the soils was determined by the Munsell method. The values in table 9 are adjusted from observations made by four persons on unsieved soil samples. The Munsell notations are given to the nearest whole hue number and to the nearest half value and chroma numbers.

LITERATURE CITED

(1) Holmes, L. C., Eckmann, E. C., Nelson, J. W., and Guernsey, J. E.
1920. Reconnaissance soil survey of the middle San Joaquin Valley, California. U. S. Bur. Soils Field Oper. 1916: 2421–2529, illus.

(2) Kelley, W. P., and Brown, S. M.
1934. Principles governing the reclamation of alkali soils. Calif. Agr. Expt. Sta., Hilgardia 8: 149–177, illus.

(3) Kellogg, C. E.
1936. Development and significance of the great soil groups of the United States. U. S. Dept. Agr. Misc. Pub. 229, 40 pp., illus.

(4) ———
1937. Soil survey manual. U. S. Dept. Agr. Misc. Pub. 274, 136 pp., illus. (Revised, 1938.)

(5) Mendenhall, W. C., Dole, R. B., and Stabler, H.
1916. Ground water in San Joaquin Valley, California. U. S. Geol. Survey Water Supply Paper 398, 310 pp., illus.

(6) Retzer, J. L., Gardner, R. A., Koehler, L. F., Cole, R. C.
1946. Soil survey of Kings County, California. U. S. Dept. Agr., Bur. Plant Indus., Soils, and Agr. Engin., Ser. 1938, No. 9, 102 pp., illus.

(7) Smith, W.
1939. Garden of the sun. 558 pp., illus. Los Angeles.

(8) Storie, R. E.
1933. An index for rating the agricultural value of soils. Calif. Agr. Expt. Sta. Bul. 556, 46 pp., illus. (Revised, 1937 and 1943.)

(9) Strahorn, A. T., Nelson, J. W., Holmes, L. C., and Eckmann, E. C.
1914. Soil survey of the Fresno area, California. U. S. Bur. Soils Field Oper. 1912, 82 pp., illus.

(10) United States Department of Agriculture.
1938. Soils and men. U. S. Dept. Agr. Yearbook 1938, 1232 pp., illus.

(11) Vandor, P. E.
1919. History of Fresno County, California. 2 vol., 1286 pp., illus. Los Angeles.

(12) Weir, W. W., and Storie, R. E.
1936. A rating of California soils. Calif. Agr. Expt. Sta. Bul. 599, 157 pp., illus.

(13) Winchell, L. A.
1933. History of Fresno County and the San Joaquin Valley. 323 pp., illus. Fresno, Calif.

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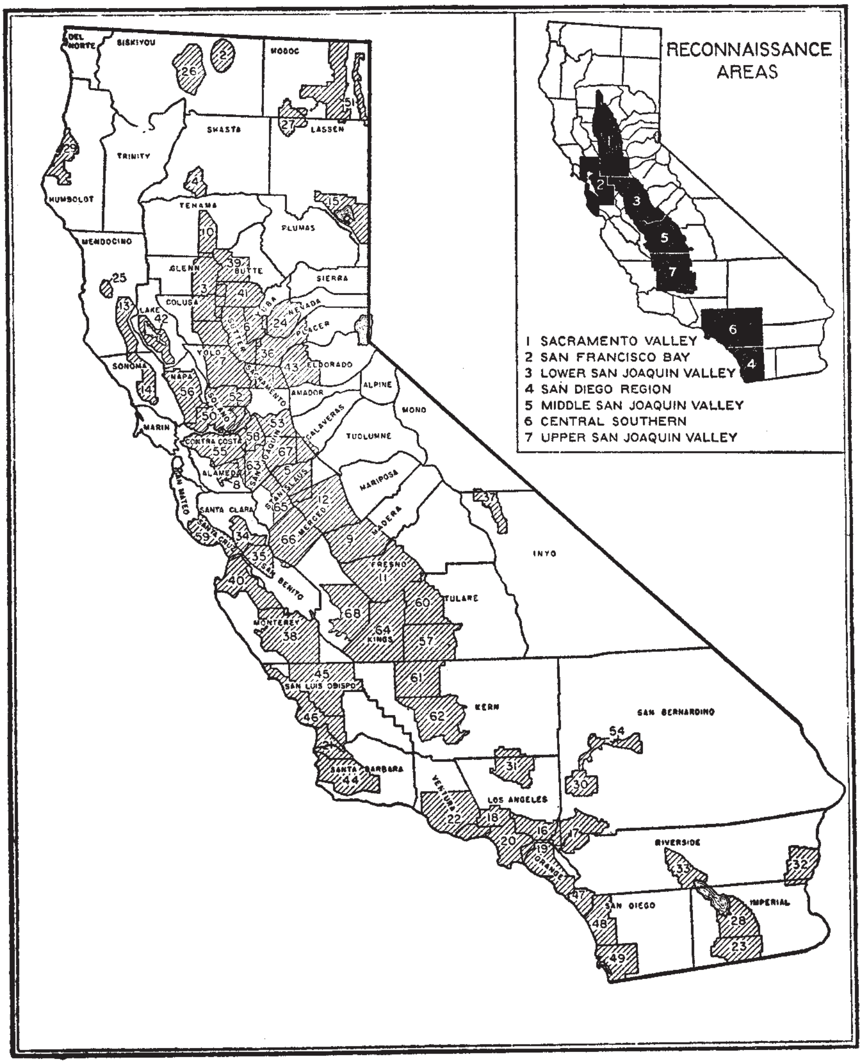

Areas surveyed in California shown by shading.

1. Sacramento
2. Butte Valley
3. Colusa
4. Redding
5. Modesto-Turlock
6. Marysville
7. Woodland
8. Livermore
9. Madera
10. Red Bluff
11. Fresno
12. Merced
13. Ukiah
14. Healdsburg
15. Honey Lake
16. Pasadena
17. Riverside
18. San Fernando Valley
19. Anaheim
20. Los Angeles
21. Santa Maria
22. Ventura
23. El Centro
24. Grass Valley
25. Willits
26. Shasta Valley
27. Big Valley
28. Brawley
29. Eureka
30. Victorville
31. Lancaster
32. Palo Verde
33. Coachella Valley
34. Gilroy
35. Hollister
36. Auburn
37. Bishop
38. King City
39. Chico
40. Salinas
41. Oroville
42. Clear Lake
43. Placerville
44. Santa Ynez
45. Paso Robles
46. San Luis Obispo
47. Capistrano
48. Oceanside
49. El Cajon
50. Suisun
51. Alturas
52. Dixon
53. Lodi
54. Barstow
55. Contra Costa County
56. Napa
57. Pixley
58. Sacramento-San Joaquin Delta
59. Santa Cruz
60. Visalia
61. Wasco
62. Bakersfield
63. Tracy
64. Kings County
65. Newman
66. Los Banos
67. Stockton
68. Coalinga

COALINGA AREA, CALIFORNIA, SOILS SUMMARY OF IMPORTANT CHARACTERISTICS

Soil	Map symbol	Dominant slope range	Soil profile: Surface	Soil profile: Subsoil	Soil profile: Parent material, or substratum	Soil depth[1]	Permeability[2]: Surface soil	Permeability[2]: Subsoil	Surface runoff	Occurrence of high water table[3]	Water holding capacity[4]	Erosion hazard[5]	Natural fertility[6]	Workability[7]	Present use or vegetative cover (crops irrigated)
Kettleman clay loam Hilly, eroded	KA	*Percent* 15–30	Light brownish-gray or grayish-brown highly calcareous clay loam	Light brownish-gray or light yellowish-brown highly calcareous clay loam	Softly consolidated calcareous fine-grained sandstone or shale	Shallow	Moderate	Moderate	Rapid	None	Low	High	Moderate	Difficult	Sheep grazing, short annual grasses
Rolling	KB	7–15	Light brownish-gray calcareous clay loam	Light brownish-gray or light yellowish-brown highly calcareous clay loam	Softly consolidated calcareous fine-grained sandstone or shale	Moderately shallow	Moderate	Moderate	Rapid	None	Moderate	Moderate	Moderate	Rather difficult	Sheep grazing, short annual grasses
Steep, eroded	KC	30+	Light brownish-gray or grayish-brown highly calcareous clay loam	Light brownish-gray or light yellowish-brown highly calcareous clay loam	Softly consolidated calcareous fine-grained sandstone or shale	Shallow	Moderate	Moderate	Rapid	None	Low	High	Moderate	Very difficult	Sheep grazing, short annual grasses
Undulating	KD	3–7	Light brownish-gray calcareous clay loam	Light brownish-gray or light yellowish-brown highly calcareous clay loam	Softly consolidated calcareous fine-grained sandstone or shale	Moderately shallow	Moderate	Moderate	Moderate	None	Moderate	Slight	Moderate	Easy	Sheep grazing, short annual grasses
Kettleman fine sandy loam Gently sloping	KE	3–7	Light brownish-gray calcareous sandy loam	Light brownish-gray or light yellowish-brown highly calcareous fine sandy loam	Softly consolidated calcareous sandstone	Moderately shallow	Moderate	Moderate	Moderate	None	Moderate	Moderate	Moderate	Easy	Sheep grazing, short annual grasses
Gently undulating	KF	1–3	Light brownish-gray calcareous fine sandy loam	Light brownish-gray or light yellowish-brown highly calcareous fine sandy loam	Softly consolidated calcareous sandstone	Moderately deep	Moderate	Moderate	Slow	None	Moderate	Slight	Moderate	Easy	Sheep grazing, short annual grasses
Hilly, eroded	KG	15–30	Light brownish-gray or light yellowish-brown calcareous fine sandy loam	Light brownish-gray or light yellowish-brown highly calcareous fine sandy loam	Softly consolidated calcareous sandstone	Shallow	Moderate	Moderate	Rapid	None	Low	High	Moderate	Difficult	Sheep grazing, short annual grasses
Rolling	KH	7–15	Light brownish-gray calcareous fine sandy loam	Light brownish-gray or light yellowish-brown highly calcareous fine sandy loam	Softly consolidated calcareous sandstone	Shallow	Moderate	Moderate	Rapid	None	Low	High	Moderate	Rather difficult	Sheep grazing, short annual grasses
Steep, eroded	KI	30+	Light brownish-gray or light yellowish-brown calcareous fine sandy loam	Light brownish-gray or light yellowish-brown highly calcareous fine sandy loam	Softly consolidated calcareous sandstone	Very shallow	Moderate	Moderate	Rapid	None	Low	High	Moderate	Very difficult	Sheep grazing, short annual grasses
Undulating	KK	3–7	Light brownish-gray calcareous fine sandy loam	Light brownish-gray or light yellowish-brown highly calcareous fine sandy loam	Softly consolidated calcareous sandstone	Moderately shallow	Moderate	Moderate	Moderate	None	Moderate	Moderate	Moderate	Easy	Sheep grazing, short annual grasses
Kettleman-Linne complex Hilly, eroded	KL	15–30	Calcareous light brownish-gray clay loam and gray or dark-gray silty clay	Calcareous light yellowish-brown clay loam and gray or light-gray silty clay	Softly consolidated calcareous sandstone and gray shale	Shallow	Moderate and low	Moderate and low	Rapid	None	Low	High	Moderate	Difficult	Sheep grazing, short annual grasses
Rolling	KM	7–15	Calcareous light brownish-gray clay loam and gray or dark-gray silty clay	Calcareous light yellowish-brown clay loam and gray or light-gray silty clay	Softly consolidated calcareous sandstone and gray shale	Moderately shallow	Moderate and low	Moderate and low	Rapid	None	Moderate	Moderate	Moderate	Rather difficult	Sheep grazing short annual grasses
Steep, eroded	KN	30+	Calcareous light brownish-gray clay loam and gray or dark-gray silty clay	Calcareous light yellowish-brown clay loam and gray or light-gray silty clay	Softly consolidated calcareous sandstone and gray shale	Shallow	Moderate and low	Moderate and low	Rapid	None	Low	High	Moderate	Very difficult	Sheep grazing, short annual grasses
Kettleman loam Gently undulating	KO	1–3	Light brownish-gray calcareous loam	Light brownish-gray or light yellowish-brown highly calcareous loam	Softly consolidated calcareous sandstone	Moderately deep	Moderate	Moderate	Slow	None	Moderate	Slight	Moderate	Easy	Sheep grazing, short annual grasses
Hilly, eroded	KP	15–30	Light brownish-gray or yellowish-brown highly calcareous loam	Light brownish-gray or light yellowish-brown highly calcareous loam	Softly consolidated calcareous sandstone	Shallow	Moderate	Moderate	Rapid	None	Moderate	High	Moderate	Difficult	Sheep grazing, short annual grasses
Rolling	KQ	7–15	Light brownish-gray calcareous loam	Light brownish-gray or light yellowish-brown highly calcareous loam	Softly consolidated calcareous sandstone	Moderately shallow	Moderate	Moderate	Rapid	None	Low	Moderate	Moderate	Rather difficult	Sheep grazing, short annual grasses
Steep, eroded	KR	30+	Light brownish-gray or yellowish-brown highly calcareous loam	Light brownish-gray or light yellowish-brown highly calcareous loam	Softly consolidated calcareous sandstone	Shallow	Moderate	Moderate	Rapid	None	Low	High	Moderate	Very difficult	Sheep grazing, short annual grasses
Undulating	KS	3–7	Light brownish-gray calcareous loam	Light brownish-gray or light yellowish-brown highly calcareous loam	Softly consolidated calcareous sandstone	Moderately shallow	Moderate	Moderate	Moderate	None	Moderate	Slight	Moderate	Easy	Sheep grazing, short annual grasses
Kettleman sandy loam Gently undulating	KT	1–3	Light brownish-gray calcareous sandy loam	Light brownish-gray or light yellowish-brown calcareous sandy loam	Softly consolidated calcareous sandstone	Moderately shallow	High	Moderate	Slow	None	Low	Slight	Moderate	Easy	Sheep grazing, short annual grasses
Hilly, eroded	KU	15–30	Light brownish-gray or light yellowish-brown calcareous sandy loam	Light brownish-gray or light yellowish-brown calcareous sandy loam	Softly consolidated calcareous sandstone	Shallow	Moderate	High	Rapid	None	High	High	Moderate	Difficult	Sheep grazing, short annual grasses
Rolling	KV	7–15	Light brownish-gray calcareous sandy loam	Light brownish-gray or light yellowish-brown calcareous sandy loam	Softly consolidated calcareous sandstone	Shallow	High	High	Rapid	None	Low	Moderate	Moderate	Rather difficult	Sheep grazing, short annual grasses
Steep, eroded	KW	30+	Light brownish-gray or light yellowish-brown calcareous sandy loam	Light brownish-gray or light yellowish-brown calcareous sandy loam	Softly consolidated calcareous sandstone	Very shallow	Moderate	High	Rapid	None	Very low	High	Moderate	Very difficult	Sheep grazing, short annual grasses
Undulating	KX	3–7	Light brownish-gray or light yellowish-brown calcareous sandy loam	Light brownish-gray or light yellowish-brown calcareous sandy loam	Softly consolidated calcareous sandstone	Moderately shallow	High	Moderate	Moderate	None	Low	Slight	Moderate	Easy	Sheep grazing, short annual grasses
Kettleman silty clay loam Rolling	KY	7–15	Light brownish-gray or grayish-brown calcareous silty clay loam	Pale-brown or light yellowish-brown calcareous silty clay loam	Softly consolidated calcareous sandstone	Moderately shallow	Moderate	Moderate	Rapid	None	Moderate	Moderate	Moderate	Rather difficult	Sheep grazing, short annual grasses
Undulating	KZ	3–7	Light brownish-gray or grayish-brown calcareous silty clay loam	Pale-brown or light yellowish-brown calcareous silty clay loam	Softly consolidated calcareous sandstone	Moderately shallow	Moderate	Moderate	Moderate	None	Moderate	Slight	Moderate	Easy	Sheep grazing, short annual grasses
Lethent silty clay Nearly level, moderate alkali	LA	0–1	Light brownish-gray or grayish-brown noncalcareous or slightly calcareous silty clay	Grayish-brown or yellowish-brown calcareous compact silty clay containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Low	Rather difficult	Sheep grazing, short annual grasses
Nearly level, moderately strong alkali	LB	0–1	Light brownish-gray or grayish-brown noncalcareous or slightly calcareous silty clay	Grayish-brown or yellowish-brown calcareous compact silty clay containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Very low	Rather difficult	Sheep grazing, short annual grasses, alkali-tolerant shrubs
Nearly level, slight alkali	LC	0–1	Light brownish-gray or grayish-brown noncalcareous or slightly calcareous silty clay	Grayish-brown or yellowish-brown calcareous compact silty clay containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, barley, cotton
Nearly level, strong alkali	LD	0–1	Light brownish-gray or grayish-brown noncalcareous or slightly calcareous silty clay	Grayish-brown or yellowish-brown calcareous compact silty clay containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Very low	Rather difficult	Alkali-tolerant shrubs and grasses
Lethent silty clay loam Hummocky, moderate alkali	LE	1–3	Light brownish-gray or grayish-brown coarse- and fine-textured material	Grayish-brown or yellowish-brown calcareous compact silty clay or silty clay loam containing gypsum	Yellowish-brown or light yellowish brown heavy-textured calcareous alluvium containing gypsum	Deep	Moderate	Low	Slow	None	High	Negligible	Low	Rather difficult	Sheep grazing, short annual grasses
Hummocky, slight alkali	LF	1–3	Light brownish-gray or grayish-brown coarse- and fine-textured material	Grayish-brown or yellowish-brown calcareous compact silty clay or silty clay loam containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Moderate	Low	Slow	None	High	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, barley and cotton where leveled
Nearly level, moderate alkali	LG	0–1	Light brownish-gray or grayish-brown noncalcareous or slightly calcareous silty clay loam	Grayish-brown or yellowish-brown calcareous compact silty clay or silty clay loam containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Moderate	Low	Very slow	None	High	Negligible	Low	Rather difficult	Sheep grazing, short annual grasses
Nearly level, slight alkali	LH	0–1	Light brownish-gray or grayish-brown noncalcareous or slightly calcareous silty clay loam	Grayish-brown or yellowish-brown calcareous compact silty clay or silty clay loam containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Moderate	Low	Very slow	None	High	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, barley, cotton
Nearly level, strong alkali	LK	0–1	Light brownish-gray or grayish-brown noncalcareous or slightly calcareous silty clay loam	Grayish-brown or yellowish-brown calcareous compact silty clay or silty clay loam containing gypsum	Yellowish-brown or light yellowish-brown heavy-textured calcareous alluvium containing gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Very low	Rather difficult	Alkali-tolerant shrubs and grasses
Levis silty clay, nearly level, strong alkali	LL	0–1	Light brownish-gray or light yellowish-brown intermittently calcareous fluffy silty clay	Grayish-brown or yellowish-brown calcareous friable silty clay	Light brownish-gray or light yellowish-brown calcareous heavy-textured alluvium containing gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Very low	Rather difficult	Alkali-tolerant shrubs and grasses
Lost Hills clay loam Gently undulating	LM	0–3	Grayish-brown or pale-brown noncalcareous clay loam	Brown or pale-brown calcareous heavy clay loam	Light yellowish-brown calcareous medium-textured alluvium	Deep	Moderate	Low	Slow	None	Moderate	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Undulating	LN	3–7	Grayish-brown or pale-brown noncalcareous clay loam	Brown or pale-brown calcareous heavy clay loam	Light yellowish-brown calcareous medium-textured alluvium	Deep	Moderate	Low	Moderate	None	Moderate	Slight	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Very gently sloping	LO	0–3	Grayish-brown or pale-brown noncalcareous clay loam	Brown or pale-brown compact calcareous heavy clay loam	Light yellowish-brown calcareous medium-textured alluvium	Deep	Moderate	Low	Slow	None	Moderate	Negligible	Moderate	Easy	Sheep grazing short annual grasses irrigation not developed
Lost Hills fine sandy loam Gently undulating	LP	1–3	Pale-brown or light yellowish-brown noncalcareous friable fine sandy loam	Pale-brown compact calcareous heavy fine sandy loam or loam	Light yellowish-brown calcareous medium- and coarse-textured alluvium	Deep	Moderate	Low	Slow	None	Moderate	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Undulating	LR	3–7	Pale-brown or light yellowish-brown noncalcareous friable fine sandy loam	Pale-brown compact calcareous heavy fine sandy loam or loam	Light yellowish-brown calcareous medium- and coarse-textured alluvium	Deep	Moderate	Low	Moderate	None	Moderate	Slight	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Very gently sloping	LS	0–3	Pale-brown or light yellowish-brown noncalcareous friable fine sandy loam	Pale-brown compact calcareous heavy fine sandy loam or loam	Light yellowish-brown calcareous medium- and coarse-textured alluvium	Deep	Moderate	Low	Slow	None	Moderate	Negligible	Moderate	Easy	Sheep grazing, short annual grasses, irrigation not developed
Lost Hills loam Gently sloping	LT	3–7	Pale-brown or light yellowish-brown noncalcareous friable loam	Brown or pale-brown compact calcareous clay loam	Light yellowish-brown calcareous medium-textured alluvium	Deep	Moderate	Low	Moderate	None	Moderate	Slight	Moderate	Easy	Sheep grazing, short annual grasses, irrigation not developed
Very gently sloping	LU	0–3	Pale-brown or light yellowish-brown noncalcareous friable loam	Brown or pale-brown compact calcareous clay loam	Light yellowish-brown calcareous medium-textured alluvium	Deep	Moderate	Low	Slow	None	Moderate	Negligible	Moderate	Easy	Sheep grazing, short annual grasses, irrigation not developed
Merced clay (adobe) Nearly level	MA	0–1	Dark-gray noncalcareous clay of adobe structure	Dark-gray to dark grayish-brown calcareous mottled moderately compact clay	Grayish-brown or olive-gray mottled calcareous fine-textured alluvium	Moderately deep	Low	Low	Very slow	Frequent	High	Protection from overflow	High	Difficult	Barley, cotton, grain sorghum
Nearly level, moderately strong alkali	MB	0–1	Dark-gray noncalcareous clay of adobe structure	Dark-gray to dark grayish-brown calcareous mottled moderately compact clay	Grayish-brown or olive-gray mottled calcareous fine-textured alluvium	Moderately deep	Low	Low	Very slow	Frequent	High	Protection from overflow	Very low	Difficult	Mostly alkali-tolerant grasses and weeds, not successfully cultivated
Nearly level, slight alkali	MC	0–1	Dark-gray noncalcareous clay of adobe structure	Dark-gray to dark grayish-brown calcareous mottled moderately compact clay	Grayish-brown or olive-gray mottled calcareous fine-textured alluvium	Moderately deep	Low	Low	Very slow	Frequent	High	Protection from overflow	Moderate	Difficult	Barley, cotton, grain sorghum
Merced clay loam, nearly level, spotted alkali	MD	0–1	Dark-gray noncalcareous clay loam	Dark-gray to dark grayish-brown calcareous mottled moderately compact clay loam or clay	Grayish-brown or olive-gray mottled calcareous fine-textured alluvium	Moderately deep	Moderate	Low	Very slow	Frequent	High	Protection from overflow	Moderate	Rather difficult	Barley, cotton, grain sorghum
Merced silty clay loam, shallow over Lethent silty clay Nearly level, moderately strong alkali	ME	0–1	Dark-gray or dark grayish-brown intermittently calcareous silty clay loam	Yellowish-brown calcareous compact silty clay, contains gypsum	Yellowish-brown heavy-textured calcareous alluvium, contains gypsum	Moderately deep	Moderate	Low	Very slow	Occasional	High	Protection from overflow	Very low	Rather difficult	Mostly alkali-tolerant grasses and weeds, not successfully cultivated
Nearly level, spotted alkali	MF	0–1	Dark-gray or dark grayish-brown intermittently calcareous silty clay loam	Yellowish-brown calcareous compact silty clay, contains gypsum	Yellowish-brown heavy-textured calcareous alluvium, contains gypsum	Moderately deep	Moderate	Low	Very slow	Frequent	High	Protection from overflow	Moderate	Rather difficult	Barley, cotton, grain sorghum
Oil-waste land	OA		Areas where sludge from oil-well drilling is deposited saturated with oil waste												
Ortigalita clay loam, gently undulating	OB	2–7	Brown noncalcareous brittle clay loam	Light yellowish-brown calcareous moderately compact clay loam	Light yellowish-brown calcareous medium-textured alluvium generally gravelly	Deep	Moderate	Low	Moderate	None	Moderate	Slight	Moderate	Rather difficult	Sheep grazing short annual grasses, irrigation not developed
Oxalis silty clay Nearly level, moderate alkali	OC	0–1	Grayish-brown calcareous silty clay	Grayish-brown or yellowish-brown calcareous silty clay, contains gypsum	Grayish-brown or yellowish-brown fine-textured alluvium, contains gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Low	Rather difficult	Barley, cotton
Nearly level, slight alkali	OD	0–1	Grayish-brown calcareous silty clay	Grayish-brown or yellowish-brown calcareous silty clay, contains gypsum	Grayish-brown or yellowish-brown fine-textured alluvium, contains gypsum	Deep	Low	Low	Very slow	None	High	Negligible	Moderate	Rather difficult	Barley, cotton, flax, grain sorghum
Panhill clay loam Gently undulating	PA	1–3	Light brownish-gray or light yellowish-brown noncalcareous or very slightly calcareous clay loam	Grayish-brown or yellowish-brown calcareous slightly compact clay loam	Pale-brown or light yellowish-brown medium-textured stratified calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Very gently sloping	PB	0–3	Light brownish-gray or light yellowish-brown noncalcareous or very slightly calcareous clay loam	Grayish-brown or yellowish-brown calcareous slightly compact clay loam	Pale-brown or light yellowish-brown medium-textured stratified calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Panhill fine sandy loam Gently undulating	PC	1–3	Light brownish-gray or light yellowish-brown noncalcareous or very slightly calcareous fine sandy loam	Pale-brown or yellowish-brown calcareous slightly compact fine sandy loam	Pale-brown or light yellowish-brown medium-textured stratified calcareous alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Very gently sloping	PD	0–3	Light brownish-gray or light yellowish-brown noncalcareous or very slightly calcareous fine sandy loam	Pale-brown or yellowish-brown calcareous slightly compact fine sandy loam	Pale-brown or light yellowish-brown medium-textured stratified calcareous alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Negligible	Moderate	Easy	Barley, cotton, grain sorghum, most of soil lies above irrigated sections
Panhill loam Gently undulating	PE	1–3	Light yellowish-brown noncalcareous or very slightly calcareous friable loam	Pale-brown or yellowish-brown calcareous slightly compact loam	Pale-brown or light yellowish-brown medium-textured stratified calcareous alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Very gently sloping	PF	0–3	Light yellowish-brown noncalcareous or very slightly calcareous friable loam	Pale-brown or yellowish-brown calcareous slightly compact loam	Pale-brown or light yellowish-brown medium-textured stratified calcareous alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Negligible	Moderate	Easy	Barley, cotton, most of soil lies above irrigated sections
Very gently sloping, slight alkali	PG	0–3	Light yellowish-brown noncalcareous or very slightly calcareous friable loam	Pale-brown or yellowish-brown calcareous slightly compact loam	Pale-brown or light yellowish-brown medium-textured stratified calcareous alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Negligible	Moderate	Easy	Barley, cotton
Panhill sandy loam Gently undulating	PH	1–3	Light yellowish-brown noncalcareous very friable sandy loam	Pale-brown or yellowish-brown calcareous light loam or sandy loam	Light yellowish-brown medium- and light-textured stratified calcareous alluvium	Deep	High	Moderate	Slow	None	Moderate	Negligible	Moderate	Rather difficult	Sheep grazing, short annual grasses, irrigation not developed
Very gently sloping	PI	0–3	Light yellowish-brown noncalcareous very friable sandy loam	Pale-brown or yellowish-brown calcareous light loam or sandy loam	Light yellowish-brown medium- and light-textured stratified calcareous alluvium	Deep	High	Moderate	Slow	None	Moderate	Negligible	Moderate	Easy	Barley, cotton, most of soil above irrigated sections
Panoche clay loam Gently undulating	PJ	1–3	Light brownish-gray or light yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Negligible	Moderate	Rather difficult	Barley, flax, cotton, grain sorghum where leveled
Very gently sloping	PK	0–3	Light brownish-gray or light yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Negligible	Moderate	Easy	Barley, flax, cotton, grain sorghum, truck crops
Very gently sloping, moderate alkali	PL	0–3	Light brownish-gray or light yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Negligible	Low	Easy	Barley, cotton
Very gently sloping, slight alkali	PM	0–3	Light brownish-gray or light yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous clay loam	Pale-brown or yellowish-brown calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Negligible	Moderate	Easy	Barley, flax, cotton, grain sorghum, truck crops
Panoche fine sandy loam Gently undulating	PN	1–3	Light brownish-gray calcareous fine sandy loam	Light brownish-gray or light yellowish-brown calcareous stratified fine sandy loam	Pale-brown or yellowish-brown calcareous stratified alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Moderate	Moderate	Rather difficult	Barley, flax, grain sorghum where leveled
Very gently sloping	PO	0–3	Light brownish-gray calcareous fine sandy loam	Light brownish-gray or light yellowish-brown calcareous stratified fine sandy loam	Pale-brown or yellowish-brown calcareous stratified alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Moderate	Moderate	Easy	Barley, flax, cotton, grain sorghum, truck crops
Very gently sloping, slight alkali	PP	0–3	Light brownish-gray calcareous fine sandy loam	Light brownish-gray or light yellowish-brown calcareous stratified fine sandy loam	Pale-brown or yellowish-brown calcareous stratified alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Moderate	Low	Easy	Short annual grasses
Panoche loam Gently undulating	PQ	1–3	Light brownish-gray or light yellowish-brown calcareous loam	Pale-brown or yellowish-brown calcareous loam	Pale-brown or yellowish-brown calcareous stratified alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Moderate	Moderate	Rather difficult	Barley, flax, cotton, grain sorghum where leveled
Very gently sloping	PR	0–3	Light brownish-gray or light yellowish-brown calcareous loam	Pale-brown or yellowish-brown calcareous loam	Pale-brown or yellowish-brown calcareous stratified alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Moderate	Moderate	Easy	Barley, flax, cotton, grain sorghum, melons, truck crops
Very gently sloping, spotted alkali	PS	0–3	Light brownish-gray or light yellowish-brown calcareous loam	Pale-brown or yellowish-brown calcareous loam	Pale-brown or yellowish-brown calcareous stratified alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Moderate	Moderate	Easy	Barley, cotton, flax, truck crops
Panoche sandy loam Gently undulating	PT	1–3	Light brownish-gray calcareous sandy loam	Pale-brown calcareous stratified sandy loam or loamy sand	Pale-brown calcareous stratified alluvium	Deep	High	High	Slow	None	Moderate to low	Moderate	Moderate	Rather difficult	Field and truck crops, much of soil not cultivated
Very gently sloping	PU	0–3	Light brownish-gray calcareous sandy loam	Pale-brown calcareous stratified sandy loam or loamy sand	Pale-brown calcareous stratified alluvium	Deep	High	High	Slow	None	Moderate to low	Moderate	Moderate	Easy	Field and truck crops, much of soil not cultivated
Panoche silty clay Very gently sloping	PV	0–3	Light brownish-gray or light yellowish-brown calcareous silty clay	Pale-brown or yellowish-brown calcareous silty clay	Pale-brown or yellowish-brown calcareous alluvium	Deep	Low	Low	Slow	None	High	Moderate	Moderate	Rather difficult	Barley, flax, cotton, grain sorghum
Very gently sloping, moderate alkali	PW	0–3	Light brownish-gray or light yellowish-brown calcareous silty clay	Pale-brown or yellowish-brown calcareous silty clay	Pale-brown or yellowish-brown calcareous alluvium	Deep	Low	Low	Slow	None	High	Moderate	Moderate	Rather difficult	Barley
Very gently sloping, slight alkali	PX	0–3	Light brownish-gray or light yellowish-brown calcareous silty clay	Pale-brown or yellowish-brown calcareous silty clay	Pale-brown or yellowish-brown calcareous alluvium	Deep	Low	Low	Slow	None	High	Moderate	Low	Rather difficult	Barley, cotton, flax, grain sorghum
Panoche silty clay loam Very gently sloping	PY	0–3	Light brownish-gray or light yellowish-brown calcareous silty clay loam	Pale-brown or yellowish-brown calcareous silty clay loam	Pale-brown or yellowish-brown calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Moderate	Moderate	Easy	Barley, flax, cotton, grain sorghum, truck crops
Very gently sloping, slight alkali	PZ	0–3	Light brownish-gray or light yellowish-brown calcareous silty clay loam	Pale-brown or yellowish-brown calcareous silty clay loam	Pale-brown or yellowish-brown calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Moderate	Moderate	Easy	Barley flax, cotton, grain sorghum, truck crops
Riverwash	RA	0–3	Loose sand and gravel, stratified				Very high	Very high		Frequent	Very low	Overflow	Very low	Very difficult	Areas supply some water and a few shade trees for stock
Sorrento clay loam, gently undulating	SA	1–3	Brown or pale-brown noncalcareous clay loam	Yellowish-brown or light-brown calcareous clay loam	Light-brown or light yellowish-brown calcareous alluvium	Deep	Moderate	Moderate	Slow	None	High	Negligible	Moderate	Rather difficult	Grazing, short annual grasses, irrigation not developed
Sorrento fine sandy loam, gently undulating	SB	1–3	Pale-brown or light yellowish-brown noncalcareous fine sandy loam	Yellowish-brown or light yellowish brown slightly calcareous fine sandy loam	Light yellowish-brown slightly calcareous stratified alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Negligible	Moderate	Rather difficult	Grazing, short annual grasses, irrigation not developed
Sorrento gravelly clay loam, gently undulating	SC	1–3	Brown or pale-brown noncalcareous gravelly clay loam	Brown or yellowish-brown calcareous gravelly clay loam	Yellowish-brown calcareous stratified gravelly alluvium	Deep	Moderate	Moderate	Slow	None	Moderate	Negligible	Moderate	Rather difficult	Grazing, short annual grasses, irrigation not developed
Temple loam, nearly level	TA	0–1	Dark-gray noncalcareous loam	Grayish-brown calcareous mottled loam or clay loam	Light olive-gray calcareous mottled stratified alluvium	Deep	Moderate	Moderate	Very slow	Frequent	High	Protection from overflow	High	Easy	Barley, cotton, grain sorghum
Temple silty clay, nearly level	TB	0–1	Dark-gray noncalcareous silty clay	Dark grayish-brown highly calcareous mottled clay loam	Light olive-gray calcareous mottled alluvium	Deep	Low	Low	Very slow	Frequent	High	Protection from overflow	High	Rather difficult	Barley, cotton, grain sorghum, alfalfa
Temple silty clay loam, nearly level	TC	0–1	Dark-gray noncalcareous silty clay	Dark grayish-brown highly calcareous mottled clay loam	Light olive-gray calcareous mottled alluvium	Deep	Moderate	Low	Very slow	Frequent	High	Protection from overflow	High	Easy	Barley, cotton, grain sorghum, alfalfa

[1] Depth of soil readily penetrated by roots above claypan, hardpan, bedrock, or other layer in the soil that would stop or hinder root penetration to a great degree Very shallow, less than 10 inches, shallow, 10 to 20 inches, moderately shallow, 20 to 36 inches, moderately deep, 36 to 60 inches, and deep, more than 60 inches

[2] Rate at which water can pass downward through the soil a short time after wetting, a general indication of the ease of root penetration Low permeability may be less than 3 surface inches of water a day, whereas high permeability may be more than 20 surface inches a day

[3] Natural occurrence estimated at time of survey and within 4 feet of the surface

[4] Total quantity of water available to plants to a depth readily penetrated by roots when the soil is at normal field-moisture capacity, approximately the moisture content of a well-drained soil 2 or 3 days after wetting For salty or alkali soils the water-holding capacity is listed as it would be if the soil contained no excess of salt Soils with an available water-holding capacity of less than 4 surface inches are considered low, those with a capacity of 9 inches of water or more, high

[5] Probable susceptibility of the soil to erosion if and when cultivated or heavily grazed It refers both to wind drifting and to erosion by water and considers soils subject to periodic overflow, unless protected by levees

[6] Natural ability of a soil to provide the proper nutrients in the proper quantities and in the proper balance for the growth of general crops when other factors as light, temperature, moisture, and physical conditions of the soil are favorable

[7] Relative extent of work required to till or level the land and relative feasibility of using farm machinery

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AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
ROBERT M. SALTER, CHIEF
DIVISION OF SOIL SURVEY, CHARLES E. KELLOGG, CHIEF

SOIL MAP
COALINGA AREA - CALIFORNIA
EASTERN SHEET

UNIVERSITY OF CALIFORNIA
AGRICULTURAL EXPERIMENT STATION
C. B. HUTCHISON, DIRECTOR
R. E. STORIE, IN CHARGE OF SOIL SURVEY

J. Kenneth Ableiter, Chief Soil Correlator.
C. P. Barnes, Chief Analyst, Soil Uses and Productivity.
Inspection and Correlation by R. C. Roberts, Principal Soil Correlator, Far Western States, and R. A. Gardner, Senior Soil Scientist.
Soils surveyed 1942-43 by F. F. Harradine, in Charge, and Alfred Smith, University of California, L. H. Smith, U. S. Department of Agriculture and H. A. Hannesson, G. L. Huntington, C. R. Horton, E. P. Whiteside, E. W. Stevenson, and P. T. Veale, Emergency Rubber Project.

Scale 1 : 63,360

1 ½ 0 1 2 3 4 Miles

5 000 0 5 000 10 000 15 000 Feet

250, 350, 450, 550, and 700 foot elevations are shown.

Map constructed by Cartographic Section, Division of Soil Survey, BPISAE.
H. W. Whitlock, Engineer, in Charge.
Planimetry from U. S. Geological Survey quadrangles.
Polyconic projection, 1927 North American datum.
10 000 foot grid based on California (Zone 4) rectangular coordinate system.

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SOIL MAP
COALINGA AREA - CALIFORNIA
WESTERN SHEET

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AGRICULTURAL EXPERIMENT STATION
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